

OPERATOR'S MANUAL

Model 869

Multi-Channel Pulse Generator

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- Don't bypass the power cord's ground lead with two-wire extension cords or plug adaptors.
- Don't disconnect the green and yellow safety-earth-ground wire that connects the ground lug of the power receptacle to the chassis ground terminal (marked with  or ).
- Don't hold your eyes extremely close to an rf output for a long time. The normally nonhazardous low-power rf energy generated by the instrument could possibly cause eye injury.
- Don't plug in the power cord until directed to by the installation instructions.
- Don't repair the instrument unless you are a qualified electronics technician and know how to work with hazardous voltages.
- Pay attention to the **WARNING** statements. They point out situations that can cause injury or death.
- Pay attention to the **CAUTION** statements. They point out situations that can cause equipment damage.



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CONTENTS

SECTION 1 GENERAL DESCRIPTION

1.1	INTRODUCTION	1-1
1.2	MAINFRAME DESCRIPTION	1-1
1.3	MODULE DESCRIPTION	1-4
1.4	MODULE CAPABILITIES	1-4
1.5	MAINFRAME SPECIFICATIONS	1-9
1.5.1	Outputs	1-9
1.5.2	Inputs	1-9
1.5.3	System Trigger	1-9
1.5.4	Internal 10 MHz Reference	1-9
1.5.5	General	1-9
1.5.6	Modules	1-9
1.5.7	Options	1-9
1.6	MODULE SPECIFICATIONS	1-10
1.6.1	Operational Modes	1-10
1.6.2	Pulse Functions	1-10
1.6.3	Pulse Characteristics	1-10
1.6.4	Input/Output Specifications	1-10
1.6.5	Interface Specifications	1-11
1.6.6	General	1-11
1.6.7	Additional Specifications and Characteristics	1-11

SECTION 2 INSTALLATION

2.1	INTRODUCTION	2-1
2.2	RECEIVING INSPECTION	2-1
2.3	UNPACKING	2-1
2.4	RETURNING EQUIPMENT	2-1
2.5	MAINFRAME INSTALLATION	2-1
2.5.1	Installation Considerations	2-1
2.5.2	Installation Procedure	2-1
2.6	ELECTRICAL INSTALLATION	2-3
2.6.1	Power Verification and Connection	2-3
2.6.2	Signal Connection	2-3
2.6.3	GPIB Connection	2-4
2.6.4	Setting the GPIB Address	2-4
2.7	MAINFRAME VERIFICATION	2-5
2.7.1	Required Test Equipment	2-5
2.7.2	Checkout Verification Record	2-5
2.8	MAINFRAME REAR PANEL	2-16
2.8.1	System Connector and Switch Functions	2-16
2.8.2	System Connector Electrical Specifications	2-16
2.9	MODULE INSTALLATION	2-18
2.10	MODULE INITIAL CHECKOUT	2-19
2.10.1	Checkout Test Equipment	2-19
2.10.2	Preparation For Use	2-19
2.10.3	Turn-On and Checkout Procedure	2-19

CONTENTS (Continued)

2.11	MODULE VERIFICATION	2-22
2.12.1	Required Test Equipment	2-22
2.11.2	Test Record	2-22
2.11.3	Pulse Definitions	2-22
2.11.4	Firmware Version Check	2-23
2.11.5	Verification Information	2-24
2.12	PERFORMANCE VERIFICATION PROCEDURES	2-24
2.12.1	Frequency Accuracy Test	2-24
2.12.2	Operating Mode Tests	2-24
2.12.3	Burst Count Test	2-27
2.12.4	Pulse Level/Amplitude Accuracy Test	2-28
2.12.5	Attenuator Accuracy Tests	2-28
2.12.6	Delay Accuracy Test	2-29
2.12.7	Width Accuracy Test	2-29
2.12.8	Transition Time/Waveform Quality Test	2-30
2.12.9	Sync Out Waveform Quality Test	2-30
2.12.10	Programmable Trigger Level/Slope Test	2-31
2.12.11	Master/Slave Mode Examples and Test	2-32
2.12.12	System Trigger Input/Output Test	2-34

SECTION 3 OPERATION

3.1	INTRODUCTION	3-1
3.2	FRONT PANEL DISPLAY ,CONTROLS, AND KEYS	3-1
3.3	FRONT PANEL DISPLAY	3-2
3.4	POWER SWITCH	3-3
3.5	NUMERIC KEYS AND CURSOR CONTROL	3-3
3.6	EXECUTE KEY	3-3
3.7	F KEYS F1 thru F6	3-4
3.8	CHANNEL SELECT KEY	3-4
3.9	RESET KEY	3-4
3.9.1	Mainframe Reset	3-4
3.9.2	Channel Reset	3-4
3.10	CAL/TEST KEY	3-5
3.10.1	Mainframe Cal/Test	3-5
3.10.2	Channel Cal/Test	3-6
3.11	STATUS KEY	3-9
3.12	STORE/RECALL KEY	3-9
3.13	MANUAL TRIGGER KEY	3-11
3.14	OUTPUT KEY	3-11
3.15	LEVEL KEY	3-12
3.16	TIMING KEY	3-12
3.17	FUNCTION KEY	3-13
3.18	MODE KEY	3-13
3.19	TRIG/SYNC KEY	3-14
3.20	SYSTEM RESOURCE MENUS	3-16
3.21	SYSTEM UTILITY MENU	3-16
3.21.1	Utility Front Panel Menu	3-16
3.21.2	Utility Time Menu	3-17

CONTENTS (Continued)

3.21.3	Utility Temperature Menu	3-19
3.21.4	Utility Diagnostic Menu	3-19
3.21.5	Utility Version Menu	3-20
3.22	SYSTEM GPIB MENU	3-20
3.23	SYSTEM CONFIGURATION MENU	3-21
3.23.1	System Sync (SSYNC) Selections	3-22
3.23.2	10 MHz Reference Selections	3-22
3.24	TYPICAL SET-UP EXAMPLES	3-23
3.24.1	System Trigger Operation Example	3-23
3.24.2	Master/Slave Example	3-25
3.25	GPIB OPERATION	3-26
3.25.1	GPIB Compliance Requirements	3-26
3.25.2	GPIB Command Definitions	3-27
3.25.3	GPIB Error Handling and Status Reporting	3-32
3.25.4	GPIB Example Program	3-32
3.26	ERROR CODES AND MESSAGES	3-33
3.26.1	Error Types	3-33
3.26.2	Normal Operation Error Codes	3-33
3.26.3	Module Self-test Error Codes	3-35
3.26.4	System Self-test (sec address 0)	3-36
3.26.5	Module Auto-Cal Error Codes	3-36
3.26.6	Quick Cal Error Messages	3-37
3.26.7	Global AutoCal Codes	3-37

APPENDICES

Appendix A	Information about Automatic Calibration	A-1
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CONTENTS

1	Introduction	1
2	Chapter I	2
3	Chapter II	3
4	Chapter III	4
5	Chapter IV	5
6	Chapter V	6
7	Chapter VI	7
8	Chapter VII	8
9	Chapter VIII	9
10	Chapter IX	10
11	Chapter X	11
12	Chapter XI	12
13	Chapter XII	13
14	Chapter XIII	14
15	Chapter XIV	15
16	Chapter XV	16
17	Chapter XVI	17
18	Chapter XVII	18
19	Chapter XVIII	19
20	Chapter XIX	20
21	Chapter XX	21
22	Chapter XXI	22
23	Chapter XXII	23
24	Chapter XXIII	24
25	Chapter XXIV	25
26	Chapter XXV	26
27	Chapter XXVI	27
28	Chapter XXVII	28
29	Chapter XXVIII	29
30	Chapter XXIX	30
31	Chapter XXX	31
32	Chapter XXXI	32
33	Chapter XXXII	33
34	Chapter XXXIII	34
35	Chapter XXXIV	35
36	Chapter XXXV	36
37	Chapter XXXVI	37
38	Chapter XXXVII	38
39	Chapter XXXVIII	39
40	Chapter XXXIX	40
41	Chapter XL	41
42	Chapter XLI	42
43	Chapter XLII	43
44	Chapter XLIII	44
45	Chapter XLIV	45
46	Chapter XLV	46
47	Chapter XLVI	47
48	Chapter XLVII	48
49	Chapter XLVIII	49
50	Chapter XLIX	50
51	Chapter L	51
52	Chapter LI	52
53	Chapter LII	53
54	Chapter LIII	54
55	Chapter LIV	55
56	Chapter LV	56
57	Chapter LVI	57
58	Chapter LVII	58
59	Chapter LVIII	59
60	Chapter LIX	60
61	Chapter LX	61
62	Chapter LXI	62
63	Chapter LXII	63
64	Chapter LXIII	64
65	Chapter LXIV	65
66	Chapter LXV	66
67	Chapter LXVI	67
68	Chapter LXVII	68
69	Chapter LXVIII	69
70	Chapter LXIX	70
71	Chapter LXX	71
72	Chapter LXXI	72
73	Chapter LXXII	73
74	Chapter LXXIII	74
75	Chapter LXXIV	75
76	Chapter LXXV	76
77	Chapter LXXVI	77
78	Chapter LXXVII	78
79	Chapter LXXVIII	79
80	Chapter LXXIX	80
81	Chapter LXXX	81
82	Chapter LXXXI	82
83	Chapter LXXXII	83
84	Chapter LXXXIII	84
85	Chapter LXXXIV	85
86	Chapter LXXXV	86
87	Chapter LXXXVI	87
88	Chapter LXXXVII	88
89	Chapter LXXXVIII	89
90	Chapter LXXXIX	90
91	Chapter LXXXX	91
92	Chapter LXXXXI	92
93	Chapter LXXXXII	93
94	Chapter LXXXXIII	94
95	Chapter LXXXXIV	95
96	Chapter LXXXXV	96
97	Chapter LXXXXVI	97
98	Chapter LXXXXVII	98
99	Chapter LXXXXVIII	99
100	Chapter LXXXXIX	100
101	Chapter LXXXXX	101
102	Chapter LXXXXXI	102
103	Chapter LXXXXXII	103
104	Chapter LXXXXXIII	104
105	Chapter LXXXXXIV	105
106	Chapter LXXXXXV	106
107	Chapter LXXXXXVI	107
108	Chapter LXXXXXVII	108
109	Chapter LXXXXXVIII	109
110	Chapter LXXXXXIX	110
111	Chapter LXXXXXX	111
112	Chapter LXXXXXXI	112
113	Chapter LXXXXXXII	113
114	Chapter LXXXXXXIII	114
115	Chapter LXXXXXXIV	115
116	Chapter LXXXXXXV	116
117	Chapter LXXXXXXVI	117
118	Chapter LXXXXXXVII	118
119	Chapter LXXXXXXVIII	119
120	Chapter LXXXXXXIX	120
121	Chapter LXXXXXXX	121
122	Chapter LXXXXXXXI	122
123	Chapter LXXXXXXII	123
124	Chapter LXXXXXXIII	124
125	Chapter LXXXXXXIV	125
126	Chapter LXXXXXXV	126
127	Chapter LXXXXXXVI	127
128	Chapter LXXXXXXVII	128
129	Chapter LXXXXXXVIII	129
130	Chapter LXXXXXXIX	130
131	Chapter LXXXXXXX	131
132	Chapter LXXXXXXXI	132
133	Chapter LXXXXXXII	133
134	Chapter LXXXXXXIII	134
135	Chapter LXXXXXXIV	135
136	Chapter LXXXXXXV	136
137	Chapter LXXXXXXVI	137
138	Chapter LXXXXXXVII	138
139	Chapter LXXXXXXVIII	139
140	Chapter LXXXXXXIX	140
141	Chapter LXXXXXXX	141
142	Chapter LXXXXXXXI	142
143	Chapter LXXXXXXII	143
144	Chapter LXXXXXXIII	144
145	Chapter LXXXXXXIV	145
146	Chapter LXXXXXXV	146
147	Chapter LXXXXXXVI	147
148	Chapter LXXXXXXVII	148
149	Chapter LXXXXXXVIII	149
150	Chapter LXXXXXXIX	150
151	Chapter LXXXXXXX	151
152	Chapter LXXXXXXXI	152
153	Chapter LXXXXXXII	153
154	Chapter LXXXXXXIII	154
155	Chapter LXXXXXXIV	155
156	Chapter LXXXXXXV	156
157	Chapter LXXXXXXVI	157
158	Chapter LXXXXXXVII	158
159	Chapter LXXXXXXVIII	159
160	Chapter LXXXXXXIX	160
161	Chapter LXXXXXXX	161
162	Chapter LXXXXXXXI	162
163	Chapter LXXXXXXII	163
164	Chapter LXXXXXXIII	164
165	Chapter LXXXXXXIV	165
166	Chapter LXXXXXXV	166
167	Chapter LXXXXXXVI	167
168	Chapter LXXXXXXVII	168
169	Chapter LXXXXXXVIII	169
170	Chapter LXXXXXXIX	170
171	Chapter LXXXXXXX	171
172	Chapter LXXXXXXXI	172
173	Chapter LXXXXXXII	173
174	Chapter LXXXXXXIII	174
175	Chapter LXXXXXXIV	175
176	Chapter LXXXXXXV	176
177	Chapter LXXXXXXVI	177
178	Chapter LXXXXXXVII	178
179	Chapter LXXXXXXVIII	179
180	Chapter LXXXXXXIX	180
181	Chapter LXXXXXXX	181
182	Chapter LXXXXXXXI	182
183	Chapter LXXXXXXII	183
184	Chapter LXXXXXXIII	184
185	Chapter LXXXXXXIV	185
186	Chapter LXXXXXXV	186
187	Chapter LXXXXXXVI	187
188	Chapter LXXXXXXVII	188
189	Chapter LXXXXXXVIII	189
190	Chapter LXXXXXXIX	190
191	Chapter LXXXXXXX	191
192	Chapter LXXXXXXXI	192
193	Chapter LXXXXXXII	193
194	Chapter LXXXXXXIII	194
195	Chapter LXXXXXXIV	195
196	Chapter LXXXXXXV	196
197	Chapter LXXXXXXVI	197
198	Chapter LXXXXXXVII	198
199	Chapter LXXXXXXVIII	199
200	Chapter LXXXXXXIX	200

1

SECTION GENERAL DESCRIPTION

1.1 INTRODUCTION

The Wavetek Model 869 Multi-Channel Pulse Generator System, shown in figure 1-1, is a bench or rack mounted test instrument.

The Model 869's hardware consists of:

1. The System Mainframe which controls and supports the modules (figure 1-1),
2. One to four Model 680-03 Pulse Generator plug-in modules(figure 1-1).

1.2 MAINFRAME DESCRIPTION

Mainframe support resources for the modules consist of a switching power supply module, front panel, VME microprocessor board, reference/calibrator board, input/output (I/O) processor board and main interconnect board (motherboard).

Figure 1-2 illustrates the interconnection of the Model 869 Mainframe. The instrumentation controller is IEEE-488.2 compatible. It can initialize and load the Model 869 with custom test setups which will automatically evaluate instrument under test.

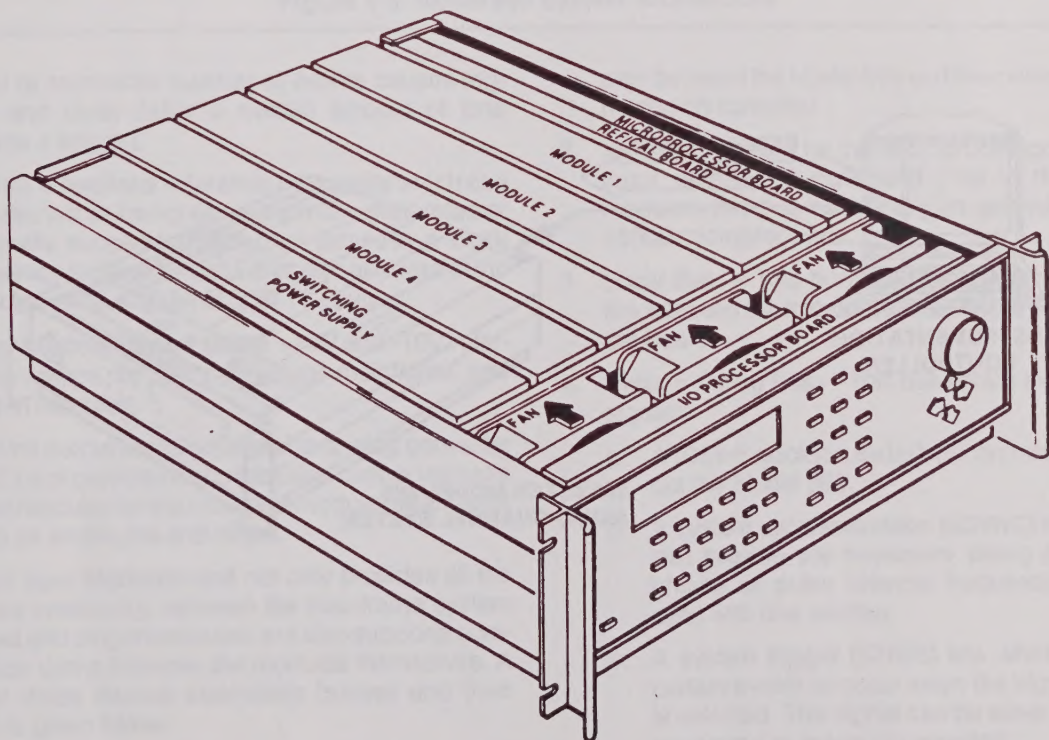


Figure 1-1. The Model 869 Multi-Channel Mainframe

Figure 1-3 illustrates the Model 869 block diagram. As previously described, the system mainframe hardware supports and interfaces with the modules used or needed for a wide range of pulse signal and timing applications.

The **I/O Processor Board**, containing a 6803 microprocessor, enables the user to communicate with the Model 869 either from the keyboard (manual operation) or from the IEEE-488 bus (remote operation). The programming commands from either source are routed to the **VME Microprocessor Board**, which contains a 68000 microprocessor, that analyzes these commands to call-up menus or execute command setups. The I/O processor board uses a liquid crystal display (LCD) to give a visual indication of front panel operation and permits the user to view menus, which define labels for function keys, current instrument parameters and warning responses of keyboard error or erroneous operation.

The **Reference/Calibration (ref/cal) board**, as its name implies, provides certain reference resource signals and voltages which are used by the mainframe system hardware to calibrate the installed pulse modules. In addition, the ref/cal board is controlled by a 6803 microprocessor which interfaces with the microprocessor board through a local bus. The specific resources provided by the ref/cal board are:

1. A DVM (3 digit) used for calibration and diagnostics of the modules.
2. A frequency counter (100 MHz) which is also used for calibration and diagnostics of the modules.
3. A system trigger source which can be, through choice, either internally generated or externally supplied. The external trigger is definable as far as slope (either positive or negative edge causes trigger), level (what amplitude causes the trigger),

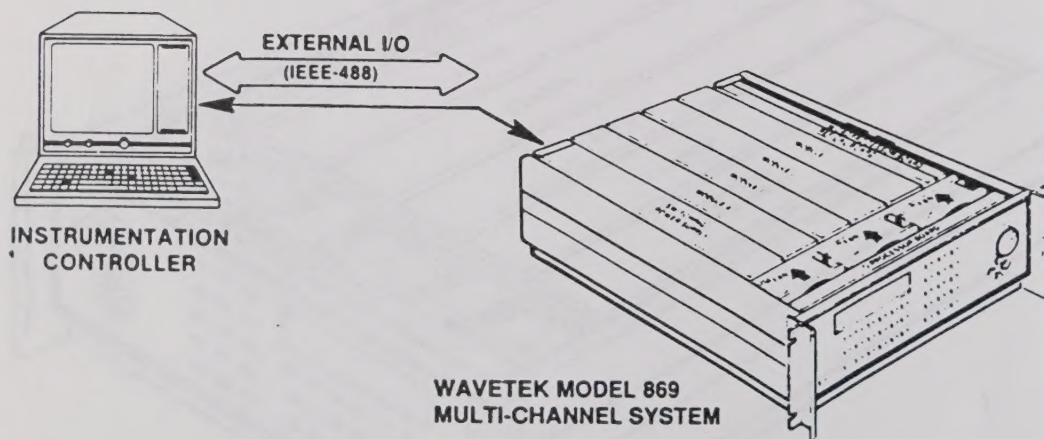


Figure 1-2. Model 869 Mainframe Interconnection

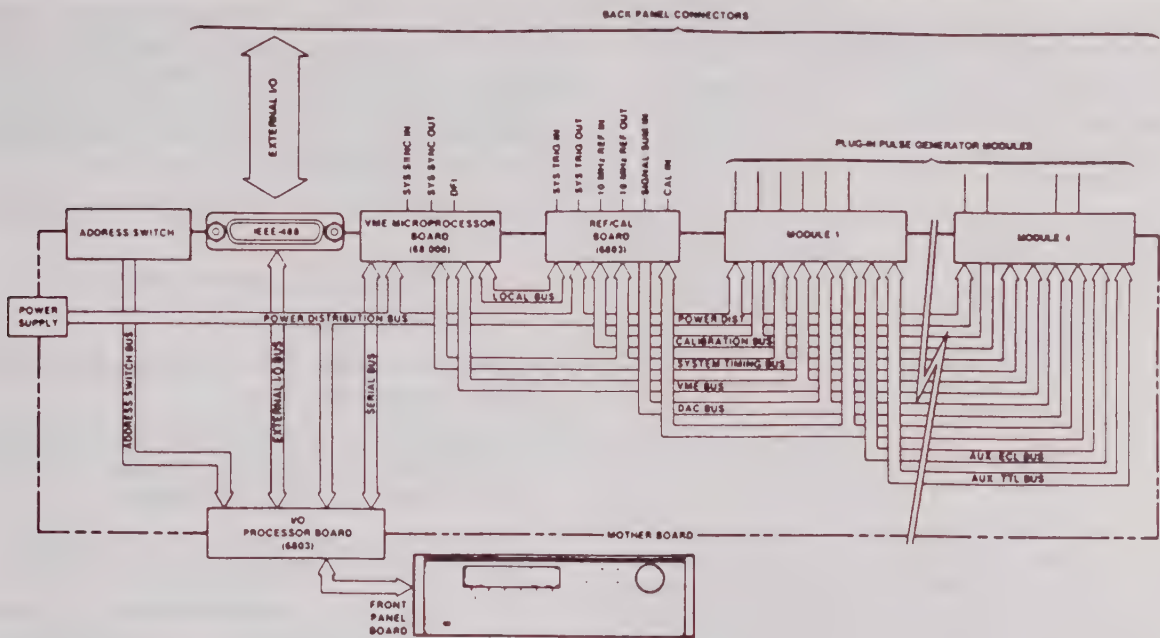


Figure 1-3. Model 869 System Architecture

event (a selectable number of events causes trigger) and delay (after a certain amount of time causes a trigger).

4. A 10 MHz oscillator reference frequency which can be selected as being either internally generated or externally supplied. This signal provides a clock frequency for logic circuits and also appears at the back panel as a 10 MHz 50Ω TTL output.
5. A highly accurate and stable +10V and -10V reference voltage for the permanent mainframe and plug-in modules.
6. A 16-bit output sampled digital to analog converter (DAC) that provides high resolution control voltages to the modules for the control of module parameters such as amplitude and offset.

The eight layer **Motherboard** not only provides all the necessary interfacing between the mainframe system resources and plug-in modules, but also supports communication paths between the modules themselves. A listing of these internal interfacing busses and their function is given below:

1. **GPB Bus** — This bus is connected between the IEEE-488 connector on the rear panel and the I/O processor board and provides the communication

path between the Model 869 and the external instrumentation controller.

2. **VME Bus** — Used by the microprocessor board to input and output command data to the option modules, this bus is basically an extension of the 68000 microprocessor.
3. **Local Bus** — This bus provides a communication link between the microprocessor board and the ref/cal board.
4. **System Timing Bus** — This bus entails three timing signals:
 - a. A 10 MHz clock for use by logic circuitry throughout the Model 869.
 - b. A system synchronization (SSYNC) line which can provide the necessary timing signals to ensure all pulse channel frequencies are in sync with one another.
 - c. A system trigger (STRIG) line which initiates certain events to occur when the trigger mode is selected. This signal can be either internally generated or externally supplied.
5. **Calibration Bus** — This ref/cal input only bus is used to supply a sampling of voltages and frequencies

from each of the plug-in modules for automatic calibration and built-in test (BIT) or self diagnostics.

6. DAC Bus — This ref/cal output bus consists of 16 high resolution analog control lines which drive the modules to control the instruments programmed parameters.
7. Analog Signal Bus — This 7 line bus providing the distribution of analog signals, is detailed as follows:
 - a. One line, titled "ANASUM", is common to the ref/cal board and all modules and is used to provide analog signal summing between any and all modules. *(Not used by the Model 680-03 Pulse Generator.)*
 - b. Three signal lines labelled sig. 4, 5 and 6 are common only to the modules.
 - c. Sig. 1, 2 and 3 are used for the pulse amplitude modulation (PAM) function and are connected between set pairs of modules, i.e., channel plug-in module slots 1 and 2, 3 and 4, 5 and 6, or 7 and 8. *(Not used by the Model 680-03 Pulse Generator.)*

The power supply provides supply voltages for the entire Model 869 via the power distribution bus. Voltages provided are: +5V, -5V, +15V, -15V, +24V, -24V, +5V isolated and a +24V pre-regulated supply.

1.3 MODULE DESCRIPTION

To operate, each Model 680-03 Pulse Generator module must occupy two adjacent module slots in the Model 869 System Mainframe Chassis.

The Pulse Generator, seen in figure 1-4, is under the control of the System Mainframe resources. It generates

pulses and square waves at the Pulse Out connector on the rear of the module, synchronization pulses at the Sync Out connector, and accepts external triggers from the Trig In connector. Additionally, other modules in the System Mainframe can interact with the Pulse Generator via the Mainframe trigger bus and sync bus.

The Pulse Generator relies on the System Mainframe for the following:

- 100% of the required operating power.
- A stable reference frequency.
- The System Trigger (STRIG) bus as a signal path for intermodule trigger signals.
- The System Sync (SSYNC) bus as a signal path for intermodule synchronization signals as in multi-channel pulse generator applications.
- The VME bus for internal control signals that supervise the entire operation of the Pulse Generator.
- The GPIB and front panel interfaces that allow user local or remote operation of module features.
- The Ref/Cal board for both automatic and quick calibration of the output amplitude, offset, delay, width and transition time circuits.

1.4 MODULE CAPABILITIES

One to four Pulse Generator modules can be installed in a Model 869 Mainframe for multi-channel pulse generator applications. The Model 869 Multichannel Pulse Generator offers the user a wide variety of programmable pulse options. The capabilities of each option are shown in table 1-1.

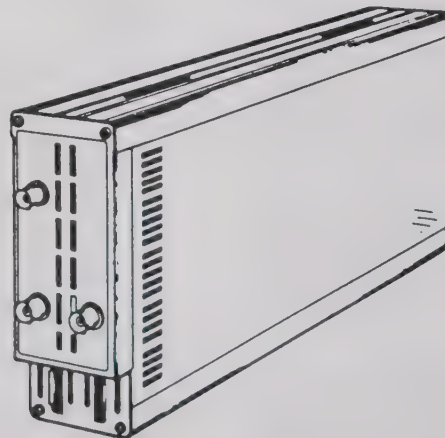


Figure 1-4. Model 680-03 Pulse Generator Module

Table 1-1. Pulse Generator Capabilities

Category	Capability	Description
"Pulse Out" Functions	Single Pulse per period (Ø delay)	The diagrams illustrate four pulse generator functions. The first shows a single pulse per period with a horizontal double-headed arrow labeled 'Period'. The second shows a single pulse with a delay per period, indicated by a horizontal arrow labeled 'Delay' between the start of the period and the pulse. The third shows two pulses per period. The fourth shows a square wave.
	Single Pulse with delay per period	
	Double Pulse per period	
	Square Wave	
"Pulse Out" Controls	OFF/ON	Opens and closes the Pulse Out relay thereby allowing or disallowing the outputting of any signals. <i>Note:</i> Output impedance is 50Ω fixed.
	Normal/Complement	The voltage polarity of the Pulse Out signal can be selected to be either positive or negative relative to its base line voltage. The diagrams show two pulse polarities. The 'Normal' diagram shows a pulse going from a lower level to an upper level, with labels 'Upper' and 'Lower' and 'Normal'. The 'Complement' diagram shows a pulse going from an upper level to a lower level, with labels 'Upper' and 'Lower' and 'Complement'. Both diagrams also show 'Leading Edge' and 'Trailing Edge' labels.
	Adjustable Levels	Both the upper and lower voltage levels of the Pulse Out waveform can be adjusted independently.
"Pulse Out" Modes	Continuous Output	Either square wave, single or double pulses can be generated continuously. The diagrams show three continuous output modes. The first is 'Continuous Squarewave', the second is 'Continuous Single Pulse', and the third is 'Continuous Double Pulse'.

Table 1-1. Pulse Generator Capabilities (Continued)

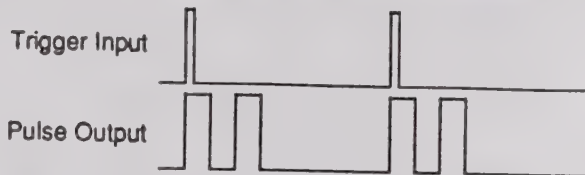
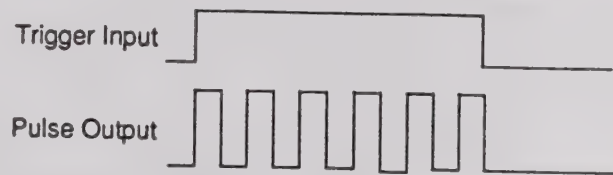
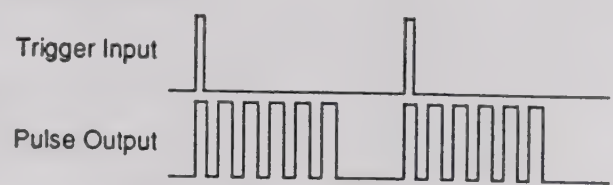
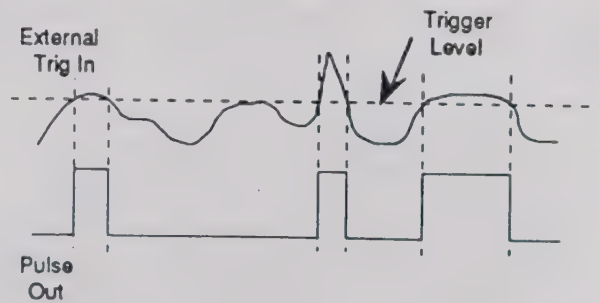
Category	Capability	Description
"Pulse Out" Modes (Cont.) <i>Note: See Trigger Input Source for trigger signal source. Manual Trigger is always enabled when Continuous Mode is not selected.</i>	Triggered Output	This shows one period of double pulses per trigger input. A single pulse per trigger input can also be selected. 
	Synchronous or asynchronous Gating	In either of the gated modes, pulses are generated at the "Pulse Out" output BNC whenever the selected trigger is asserted. Asynchronous gating causes the output pulse to terminate with the reset of the selected trigger. Synchronous gating will cause the waveform to continue beyond the reset of the selected trigger and until the end of the current pulse width. 
	Burst	Up to 1×10^7 cycles (bursts) can be programmed for generation by the user. Generation begins when an input trigger is detected. 
	External Width	An output will be developed whenever the input trigger voltage exceeds the programmed trigger level. 

Table 1-1. Pulse Generator Capabilities (Cont)

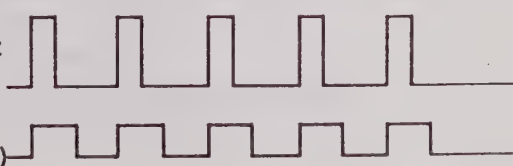
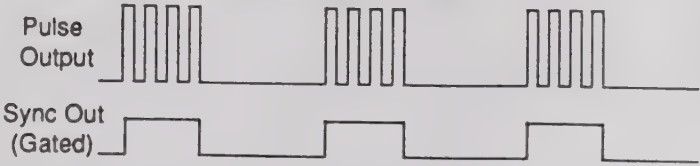
Category	Capability	Description
"Pulse Out" Waveform Timing	Variable Frequency or Period	Pulse rate can be set in terms of frequency or period.
	Variable Delay	a) The amount of delay time relative to the Sync Out when generating single pulses can be controlled. b) The amount of time between the leading edge of the first pulse and the second pulse when generating double pulses can be controlled. (See "Pulse Out" Functions.)
	Variable Pulse Width	Output pulse width can be controlled.
	Variable Transition Times	Both the leading and trailing edge transition time can be set independently of each other and are variable within specified limits.
Trigger Input Source	Internal (STRIG Input)	The System Trigger (STRIG) from the internal motherboard is used by the Pulse Generator module for triggered events.
	External	The External Trigger input (TRIG IN) is used by the Pulse Generator module for triggered events. <i>Note: Trigger polarity and the voltage level at which the external trigger becomes valid can be selected.</i>
System Trigger bus (STRIG Output)	Off	Disables all of the pulse outputs to the System Trigger Bus (STRIG).
	External Trigger	The module External Trigger input (TRIG IN) is coupled to the internal System Trigger bus (STRIG).
	Delay	The pulse signal output from the pulse delay circuit is applied to the internal System Trigger bus (STRIG).
	Width	The pulse output signal from the width circuit is applied to the internal System Trigger bus (STRIG).
	Sync Out	The signal appearing at the "Sync Out" connector is coupled to the internal System Trigger bus (STRIG).
"Sync Out"	Off	The Sync Out relay is opened and output is high impedance.
	Clock	This is a continuous squarewave at the selected Pulse Generator frequency Pulse Output  Sync Out (Clock Config)

Table 1-1. Pulse Generator Capabilities (Cont)

Category	Capability	Description
	Gated	The Sync Out level is held high during pulse burst output. The output goes low when the pulses cease.  Pulse Output Sync Out (Gated)
Master/Slave <i>Note:</i> <i>For modules installed in a Model 869 for multi-channel pulse generator applications, channel 1 is by default the master and all other channels are slaves. It can be re-defined by the user.</i>	Independent	When operating independently, the Pulse Generator module provides no signal to and uses no signal from the System Sync bus (SSYNC).
	Master	Provides a clock signal to the System Sync Signal bus for other modules to use as clock source (the same signal that appears at the Sync Out connector.)
	Slave	The Pulse Generator module uses the System Sync Signal bus as a clock signal instead of the internal clock source.
AutoCal	Stored Electronic Calibration	Electronically optimizes the accuracy of all the parameters. These optimized data are retained in the Mainframe non-volatile RAM and are valid until another AutoCal is performed. The status value code from the last AutoCal can be obtained thru a menu selection on the front panel display.
Quick Cal	Temporary Electronic Calibration	Electronically optimizes the accuracy of the current amplitude, delay, width, and transition time parameters. These optimized parameters are not retained in the Mainframe non-volatile RAM and are valid only as long as the parameter is not changed.
Self-test	Operational Tests	Provides a functional "pass/fail" test on most of the Pulse Generator circuits. Passing the test does not necessarily guarantee that the generator performs to and meets all of the specifications The status value code from the last Self-test can be obtained thru a menu selection on the front panel display. This status should be read before resetting or turning the machine off which resets the status code to 00h.

1.5 MAINFRAME SPECIFICATIONS

1.5.1 Outputs

System Sync Output and System Trigger Output:

Source selected by Master/Slave/Independent keys.

Signal Level: 0.2 to 1.0V into 50 Ω typ.

Transition Time: <10 ns.

Output Impedance: 50 Ω .

10 MHz Reference Output: 0.2 to 2.4V into 50 Ω (TTL for >10 k Ω).

Transition Time: <10 ns into 50 Ω .

Output Impedance: 50 Ω .

DFI Output: (Discrete Fault Indicator.) Relay contact closure to indicate fault condition for power off, microprocessor failure or over-temperature.

1.5.2 Inputs

System Sync Input: Selected by Slave mode TTL levels required.

Input Impedance: >1 k Ω .

Bandwidth: >20 MHz.

System Trigger Input: A signal between 1 Vpp and 10 Vpp will trigger the system.

Frequency: <20 MHz for Normal trigger and <5 MHz for Delayed and Event trigger.

Transition Time: <50 ms.

Minimum Pulse Width Requirement: 25 ns.

Impedance: >1 k Ω .

10 MHz Reference Input: 1 Vpp min to 10 Vpp.

Range: >10 MHz $\pm$ 5%.

Input Impedance: >1 k Ω .

Calibration Input: Used to calibrate the internal DVM. $\pm$ 4 Vdc $\pm$ 0.1 mV.

1.5.3 System Trigger

External Trigger

Modes: Normal, Time Delay, Event Delay.

Delay Range: 100 ns to 10s.

Resolution: 100 ns.

Accuracy: $\pm$ (1% + 30 ns).

Event Delay: 2 to 1×10^7 events with selectable slope.

Internal Trigger

Frequency Range: 0.01 Hz to 10 MHz.

Resolution: 4 digits.

Accuracy: 0.05%.

1.5.4 Internal 10 MHz Reference

Accuracy: $\pm$ 1 ppm, 15° to 35°C.

Stability: $\pm$ 1 ppm/year (typ).

1.5.5 General

Stored Settings: 99 stored settings are provided by the chassis. These are allocated as needed between the chassis and installed modules.

GPIB Programming: The software interface uses a subset of the IEEE-488.2 Draft Standard, "Codes, Formats, Protocols and Common Commands for use with ANSI/IEEE Std 488.1-1987. IEEE Standard Digital Interface for Programmable Instrumentation," version dated 27 March 1987 as a general guide.

IEEE-488 Subsets*: SH1, AH1, TE6, LE4, SR1, RL1, PP0, DC1, DT1 and E1.

* Refer to paragraph 3.25.1 for details.

Environment

Operating Range: 0° to +50°C.

Relative Humidity: 95% non-condensing at 25°C.

Altitude: 10,000 ft.

Storage: -40° to +75°C, 40,000 ft.

Dimensions:

Height: 17.78 cm (7 in.)

Length: 54.6 cm (21.5 in.)

Width: 44.5 cm (17.5 in.)

Supplied with rack mount adapters

Weight:

Chassis only; 17.3 kg (38 lb) net

With 1 module; 22.9 kg (51 lb) net

With 2 module; 24.9 kg (55 lb) net

With 3 module; 26.9 kg (59 lb) net

With 4 module; 28.9 kg (64 lb) net

Add 3.6 kg (8 lb) for shipping weight.

Power: 90 to 126.5 Vac, 200 to 250 Vac, 48 to 66 Hz.

<50 watts chassis only,

Add 50 watts for each module installed.

Extender Cards: Four 96 pin cards are required per module.

1.5.6 Modules

Model 680-00: Blank Module

A Blank Module must be ordered to fill each unused slot. They provide continuity for the interrupt daisy chain and for proper cooling.

Model 680-03: 100 MHz Module

A 100 MHz, 10 Vpp Pulse Generator module, with variable transition time control. Up to four channels, operated independently or slaved, can be installed in the same chassis.

1.5.7 Options

Model 680-010: MATE-CIIL Interface

To be developed.

1.6 MODULE SPECIFICATIONS

These specifications are for each channel unless otherwise noted.

1.6.1 Operational Modes

Continuous	Triggered
Synchronized Gate	Asynchronized Gate
Burst (75 MHz max)	External Width

1.6.2 Pulse Functions

Minimum Frequency: 10 MHz.

Maximum Frequency

Square Wave: 200 MHz. (No delay.)

Single Pulse: 100 MHz.

Double Pulse: 50 MHz.

Resolution: 5 digits

Accuracy: 5 ppm

Stability: 2 ppm, 10 min.

Burst: 2 to 10^7 counts.

1.6.3 Pulse Characteristics

Width

Range: 5 ns to 2000s.

Resolution: 10 digits limited to 100 ps

Monotonicity: 500 ps.

Accuracy ⁽¹⁾:

Width ≤ 15 ns: ± 1 ns.

Width 15 ns to ≤ 100 ns: $\pm(1\% + 2$ ns)

Width > 100 ns: $\pm(1\% + 5$ ns)

Delay

Range: 0 ns to 2000s

Resolution: 10 digits limited by 100 ps

Monotonicity: 500 ps.

Accuracy ⁽¹⁾: $\pm(1\% + 2$ ns).

Transition Time

Resolution: 3 digits limited by 10 ps

Minimum variable: 20% to 80%: <1.2 ns.

10% to 90%: <2.0 ns.

Maximum variable: >20 μ s

Square: Fixed <2 ns when >100 MHz.

Leading & Trailing edge ratio:

1:20 to 20:1 in 4 ranges

Program Accuracy:

For 1:1 up to 1:10* and Pulse Level in top 50% of Amplitude Range: $\pm 5\% \pm 2$ ns.

For 1:10 up to 1:20*: $\pm 10\% \pm 2$ ns in above amplitude range.

For Any Ratio* when Upper Pulse Level is 30% to 50% of Amplitude Range: $\pm 10\% \pm 2$ ns.

*Ratio of pulse leading edge time to trailing edge time.

1:1 is range min; 1:20 is range max.

Jitter <200 ps from Pulse Out to Sync Output, clock output selected.

Levels ⁽²⁾

Upper Level

Range: -4.0 to $+10.0$ V ⁽³⁾.

Resolution: 5 mV.

Accuracy: ± 200 mV.

Lower Level

Range: -5.0 to $+9.0$ V ⁽³⁾.

Resolution: 5 mV.

Accuracy: ± 200 mV.

Peak to Peak

Range: 0.125 to 10.0 V ⁽³⁾.

Resolution: 5 mV.

Accuracy: $\pm 2\% \pm 50$ mV.

Aberrations: $\pm 5\%$ or 350 mV ⁽⁴⁾.

1.6.4 Input/Output Specifications

Trigger In

Input: External or system bus

Input Impedance: $50\Omega \pm 3\Omega$

Range: -10 to $+10$ V

Resolution: 100 mV

Accuracy: ± 200 mV

Slope: positive or negative.

Signal Requirements:

Transition time: <100 μ s

Pulse width: >5 ns

Maximum frequency: 75 MHz min.

(Maximum is $<1/2$ pulse frequency for asynchronous gate).

Input Voltage Range: ± 11 V

Minimum Amplitude: 1 Vpp

Trigger Delay

Trigger Input to Pulse Output

Mode	Typical delay
Triggered	30 ns
Synchronized gate	50 ns
Asynchronized gate	50 ns
Burst	50 ns
External width	15 ns

Sync Output

Impedance: $50\Omega \pm 3\Omega$

Output: On/Off, select clock or gate.

Level: <0.2 V to >1.0 V into 50Ω ; <0.4 V to >2.0 V into >10 k Ω .

Transition Time: <5 nsec

Pulse Output

Impedance: $50\Omega \pm 3\Omega$

Output: On/Off.

1.6.5 Interface Specifications

System Trigger Output (Internal Bus)

off
external
delay
width
sync

System Sync (Internal Bus)

One to four Model 680-03 Pulse Generator modules may be configured as:

Independent (internal or external clock).
Master (outputs clock to system sync)
Slave (use system sync as clock).
Frequency to 100 MHz maximum

Channel To Channel Skew

Master to Slave: Typical <5 ns, 1 to 3 dependent modules.

QuickCal: A utility to optimize the current setting. No stored calibration constants are updated.

AutoCal: Auto-alignment of operational parameters. Calibration constants are adjusted and stored.

1.6.6 General

Interface: IEEE 488.1

Model 680 Compatibility

Mainframe Firmware requirements
680 System: version 1.40 or later
680 Ref/Cal: version 3.0 or later
680 Front Panel: Any version

Slot Requirements

Number of Slots: Two slots per module.

Power: <50 Watts

Module Compatibility: All.

Slot Placement: Any two adjacent slots.

Stored Settings

- Provided by the Chassis. There are 99 non-volatile stored settings that can be divided between chassis and modules to meet user needs.

Features Not Supported: Analog sum bus; pulse AM

Physical Specifications.

Dimensions:

Height: 15.9 cm (6.25 in.)
Length: 41.9 cm (16.50 in.)
Width: 6.1 cm (2.40 in.)

Weight: 2.9 kg (6.4 lb)

Specifications apply under the following conditions:

- >20 minute warm up.
- Calibrated in the last 9 months.
- Ambient temperature stable $\pm 3^{\circ}\text{C}$ for >20 minutes
- Within $\pm 10^{\circ}\text{C}$ of ambient temperature when calibrated.
- Within operating range of 0 to $+50^{\circ}\text{C}$.
- Levels are measured with waveform aberrations excluded for frequencies < 20 MHz.

NOTES

^[1] Measured with fastest transition times.

^[2] Worst-case specification. Specs apply for range 1 attenuation. Ranges 2, 3 and 4 have improved specs.

^[3] Attenuation-range dependent.

^[4] Whichever is greater.

1.6.7 Additional Specifications and Characteristics

Power Supply Requirements

The following are the approximate current and requirements from each of the power supplies provided by the Model 680 Mainframe:

+5	3.0 A	15.0 Watts
-5	0.7 A	3.5 Watts
+5 (Iso)	25 mA	0.1 Watts
+15	0.9 A	13.5 Watts
-15	0.2 A	3.0 Watts
+24	0.4 A	9.6 Watts
-24	0.6 A	14.4 Watts
-12	none	
+12	none	

Total power: 59.1 Watts

NOTE

Typically it is <50 Watts per channel because not all supplies draw maximum current at the same time.

Calibrations

Automatic calibration: Most of the pulse parameters can be calibrated automatically with the exception of the analog pulse width and delay circuits.

Additional Information for Upper Level and Amplitude Specifications:

For optimum waveform quality, (Attenuator enabled) the output amplifier will operate with a pulse amplitude of from 5.005 Vpp to 10 Vpp whenever possible. For pulse amplitudes less than 5 Vpp with low offsets, the output is achieved by the use of a 2X, 4X, or 8X attenuator.

If a small pulse amplitude in combination with a large offset is selected, the output amplifier will be forced to

operate below its optimum performance limit, 1 to 5 Vpp, with little or no attenuation.

With the output attenuator enabled, the attenuation range selection is automatic. To achieve minimum transition times (<2ns) for amplitudes from 1 to 5 Vpp, use the 1X amplitude range by disabling the attenuator using the front panel or program control.

See the two Figures in next page to determine the attenuator range and accuracy.

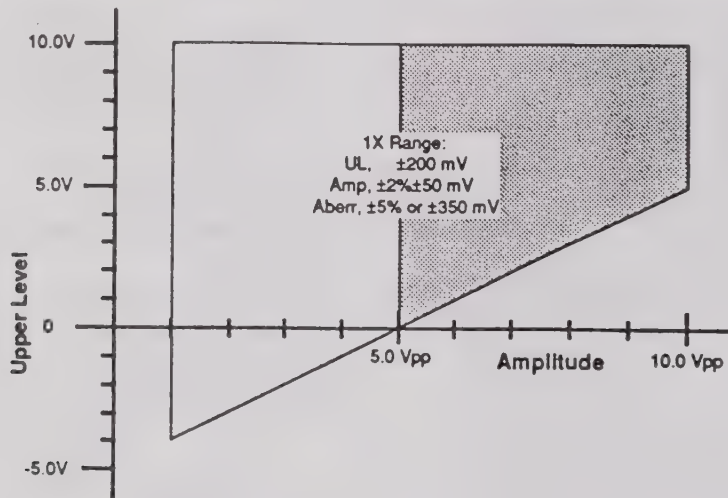


Figure 1-5. Upper Level / Amplitude Specifications, Attenuator Disabled.

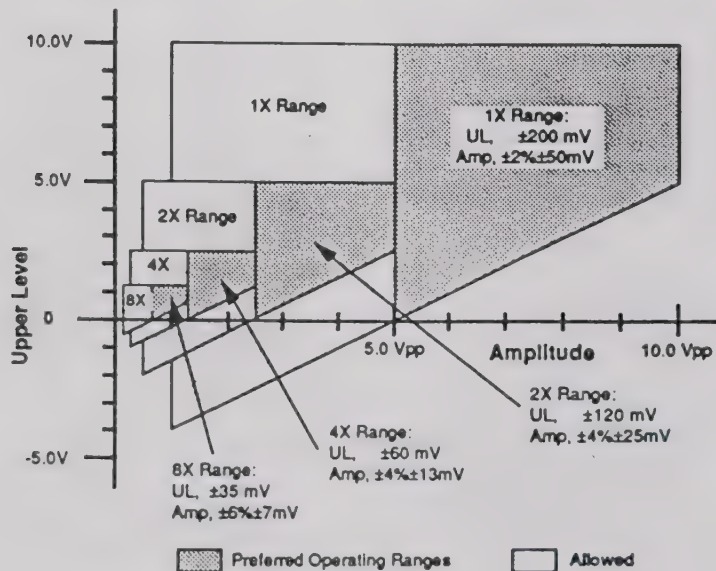


Figure 1-6. Upper Level / Amplitude Specifications, Attenuator Enabled.

Additional Information for Transition Time specifications:

To determine the attenuator range and specifications from figure 1-7:

1) Mark and draw a vertical line through the desired

amplitude on the horizontal axis.

2) Mark and draw a horizontal line through the desired Upper Level on the vertical axis.

3) The intersection of the two lines indicates the attenuator range used and range specifications.

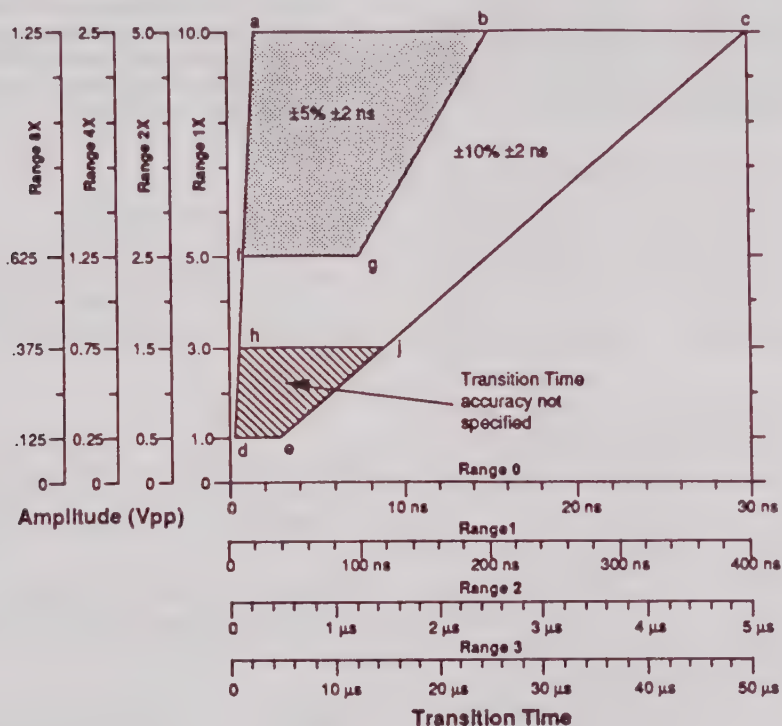


Figure 1-7. Allowable Transition Time Ranges and Specifications.

In reference to the above figure:

Transition	a	b	c	d	e	f	g	h	j
Range 0	<2 ns	15 ns	30 ns	<1.5 ns	3 ns	<1.5 ns	7.5 ns	<1.5 ns	9 ns
Range 1	20 ns	200 ns	400 ns	2 ns	40 ns	10 ns	100 ns	6 ns	120 ns
Range 2	250 ns	2.5 μs	5.0 μs	25 ns	500 ns	125 ns	1.25 μs	75 ns	1.5 μs
Range 3	2.5 μs	25 μs	50 μs	250 ns	5 μs	1.25 μs	12.5 μs	750 ns	15 μs

Transition Time Range Limits and Accuracy (10% to 90%):

To Determine the Transition Time Range and specifications from Figure above:

- 1) Using the Upper Level and Amplitude Figures provided, determine the attenuator range used.
- 2) Mark and draw a horizontal line through the amplitude selected across the Transition Time Figure.
- 3) Mark the desired leading and trailing edge transition times on one of the horizontal transition time scales. Draw vertical lines through the marks. Both transition time must be in the same range.

- 4) Both intersects of the three lines must fall within the area "aced" to be valid. Transition accuracy is indicated inside the area.

NOTE

- 1) *Transition time range limits vary in proportion with amplitude.*
- 2) *Transition time and amplitude Range selection are automatic based on programmed values..*
- 3) *Both leading and trailing edge transition times must be programmed within the same range to be valid.*
- 4) *Amplitude attenuation range does not affect the transition time setting and accuracy.*

2

SECTION INSTALLATION

2.1 INTRODUCTION

This section provides receiving, inspection, installation, and checkout procedures for the Model 869. Installation instructions for individual function modules are detailed in paragraph 2.9.

2.2 RECEIVING INSPECTION

Check the shipment at the time of delivery for missing boxes and inspect each box for damage. Describe any box damage and list any shortages on the delivery invoice.

2.3 UNPACKING

1. **Unpack the boxes.** Unpack the boxes in a clean and dry environment. Save all the packing materials in case the instrument(s) have to be returned for repair.
2. **Inspect the equipment for damage.** Inspect the equipment carefully for any signs of mechanical damage regardless of the condition of the shipping boxes.
3. **If necessary, file a damage claim.** In the case of mechanical damage, call the shipper immediately and start the claim process.
4. **Call Wavetek.** Call Wavetek's Customer Service Department (619-279-2200) to inform them that the shipment arrived damaged. Please be prepared to provide a detailed damage report.

2.4 RETURNING EQUIPMENT

Follow these steps when you return equipment to Wavetek:

1. **Save the packing material.** Always return equipment in its original packing material and boxes. If you use inadequate material, you'll have to pay to repair any shipping damage as carriers won't pay claims on incorrectly packed equipment.
2. **Call Wavetek Customer Service and ask for a return authorization.** Wavetek's Customer Service representative (619-279-2200) will ask for your

name, telephone number, company name, equipment type, and a description of the problem.

3. **Pack and ship the equipment.**

2.5 MAINFRAME INSTALLATION

The following paragraphs contain information on mechanically installing the Model 869 on a bench top or in a standard 19-inch rack. (Refer to paragraph 2.9.)

2.5.1 Installation Considerations

1. Mounting

The Model 869 can be used as a conventional stand-alone bench test instrument or it can be rack mounted (refer to figure 2-1) in a standard 7-inch by 19-inch panel opening. Rack mounting requires either chassis rails that are mounted inside the rack or rack slides that are fastened to the left and right side of the chassis using pre-drilled holes. The chassis rails can be purchased or fabricated locally. The Wavetek part number for the rack slides is 1000-00-0358. These are 22-inch rack slides that will provide up to 24 inches of travel. The rack slides can be installed in either a 22 or 24-inch cabinet (a 24-inch cabinet requires adapters).

2. Cooling

The Model 869 uses perforations in the top and bottom covers as intakes for cooling air. At least 1/2 inch of space around the perforations is required for cooling to enter the instrument; at least three inches of space behind the instrument is required for exhaust air to leave the instrument. When the Model 869 is rack mounted, the rack must provide adequate cooling air around the instrument and a means for the instrument to exhaust the warm air from the rear panel.

2.5.2 Installation Procedure

Install the Model 869 using the procedures listed below. Adapt the steps as necessary to suit your requirements (steps 3 and 5 are optional depending on the installation requirements). The paragraphs given at the end of each

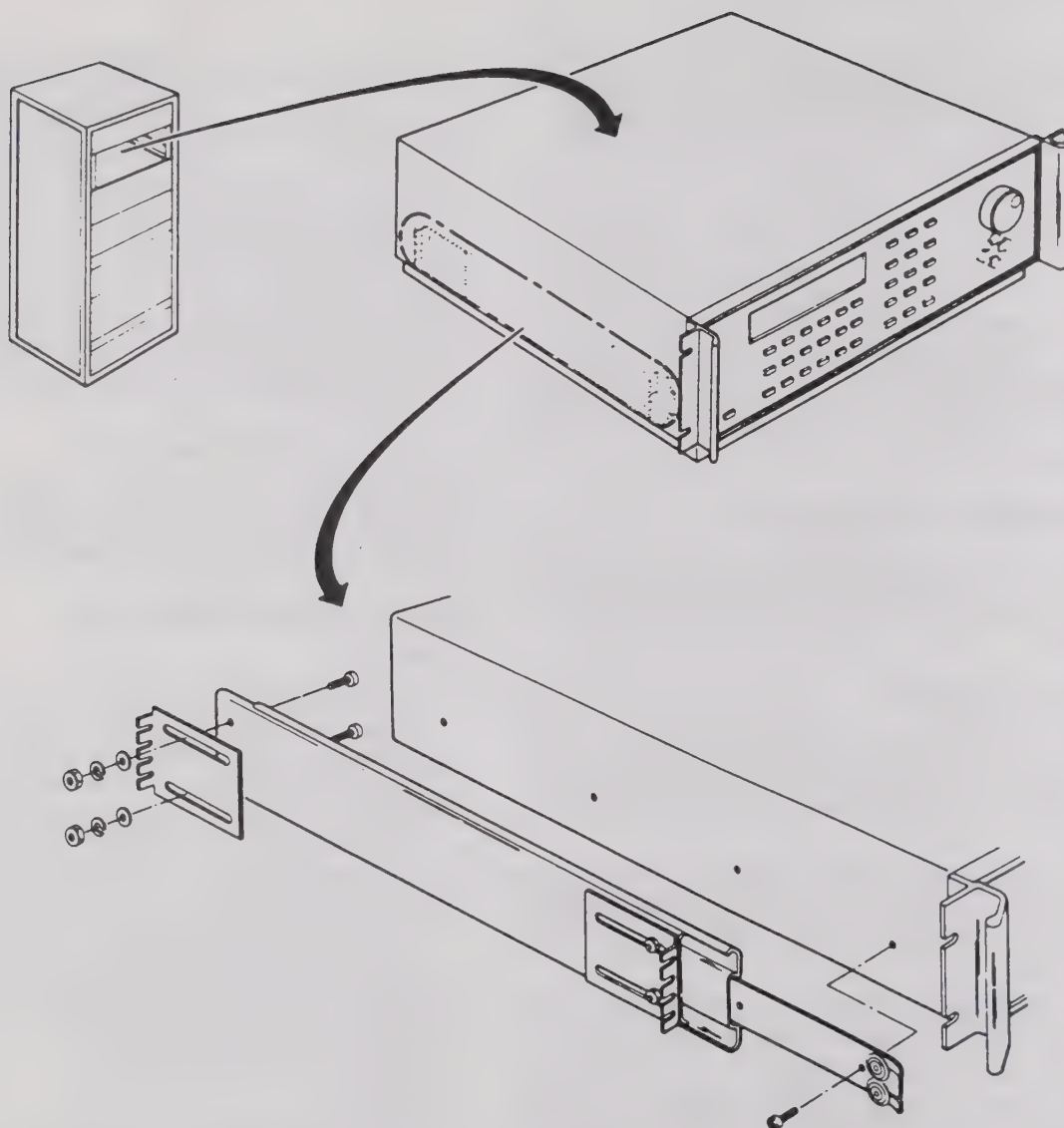


Figure 2-1. Rack Mount Installation

step contain detailed information on performing the step.

1. Verify that the ac power and fuse configurations are correct (refer to paragraph 2.6.1).
2. Verify that all of the cables and accessories required are properly installed and/or connected (refer to paragraph 2.6.1, and 2.6.2).
3. Set the GPIB address. (Refer to paragraph 2.6.4.)
4. Verify that the instrument passed the Mainframe Verification Procedure in paragraph 2.7 and the Module Initial Checkout in paragraph 2-10.

5. If the Model 869 will be used as a bench-top unit, the instrument is now ready for use. If the Model 869 will be rack mounted, continue with the following steps.
6. Remove the three (3) screws securing the bottom cover to the chassis, then remove the bottom cover.

NOTE

To accomplish the following step, it may be necessary to break a sticker placed over one of the screws. Breaking this sticker will NOT void any warranty.

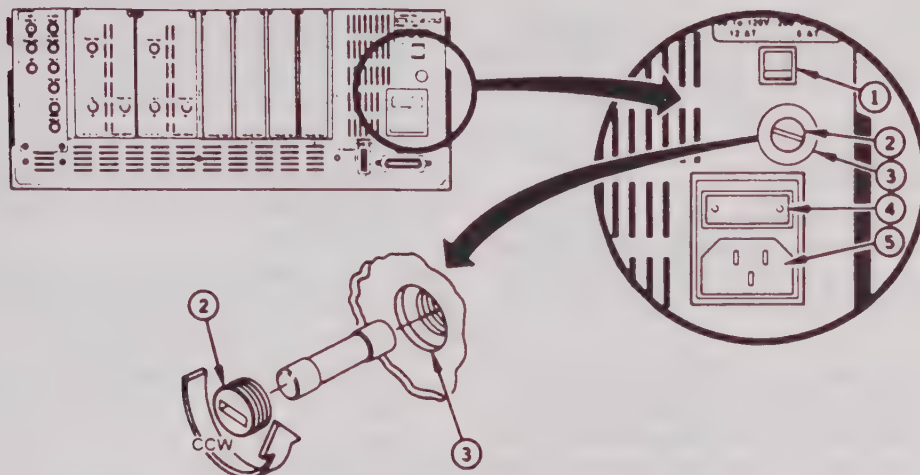


Figure 2-2. Voltage Selector Switch and Fuse Assembly

7. Remove the four (4) rubber feet at the bottom of the instrument :

CAUTION

Store the feet and mounting hardware in a location where they can be easily found. If the instrument is used as a bench unit in the future, these feet must be mounted on the bottom cover to prevent overheating.

8. Replace the bottom cover and the three (3) screws that secure it to the chassis.
9. Install the Model 869 in a rack mount (refer to paragraph 2.5.1).

2.6 ELECTRICAL INSTALLATION

The following paragraphs contain information on electrically connecting the Model 869 to the ac power source and to the signal processing and generating instruments.

2.6.1 Power Verification and Connection

Use figure 2-2 and the following procedure to verify and, if necessary, configure the Model 869 to accept the available line voltage.

1. Place the Model 869 front panel **Power** switch to the "Standby" position and the rear panel power switch to the "0" (OFF) position (4). Remove the power cord from the Model 869 rear panel power input connector (5).

2. If the correct voltage rating is not displayed on the voltage selector switch (1), use a straight slot screwdriver to set the switch to the correct voltage (115 V or 230 V).
3. Use a straight slot screwdriver to unscrew (CCW) the slotted cap (2) from the fuse holder assembly (3).
4. Remove the cap and fuse and check the fuse current rating. The label on the Model 869 rear panel calls out the correct rating.
5. If correct, reinstall the fuse and slotted cap in the fuseholder. If not correct, replace the fuse with one of the correct rating and then install the fuse and slotted cap in the fuseholder.
6. Connect the ac power cord to the power connector on the instrument rear panel (5).
7. Connect the power cord to the line power source.
8. Place the rear panel Power Switch to the "I" (ON) position (4).

2.6.2 Signal Connection

All signal connectors (and power connectors) are located on the rear panel. The signal connectors fall into two groups: the "system" connectors located on the left side of the rear panel and the "instrument module" connectors that are located on the applicable module. The only exception is the GPIB connector; it is located on the lower right side of the rear panel. Use RG-223/U or equivalent 50Ω coaxial cable terminated with BNC connectors to distribute all of the signals (except for the GPIB signals). For applications where different source/load impedances are used, select the appropriate

cables. Some modules will have their own cables provided for special connectors.

To determine the exact signal connection requirements for the planned installation, refer to paragraph 2.8 of this manual which contains the rear panel "system" connector description.

2.6.3 GPIB Connection

When connected to a General Purpose Instrumentation Bus (GPIB), an external instrumentation controller can control the operation of the Model 869. Connect to this bus with the standard IEEE-488 connector located on the rear panel.

Standard pre-wired GPIB bus cables are available from Wavetek in one meter (p/n 6001-50-0006) and two meter (p/n 6001-50-0007) lengths and are used to connect the Model 869, and other instruments on the bus, to an instrumentation controller. Table 2-1 gives the signal carried by each pin of the GPIB connector (Amphenol 57-10240 or equivalent).

Table 2-1. GPIB Connector Pin Functions

Pin	Signal	Pin	Signal
1	DIO1	13	DIO5
2	DIO2	14	DIO6
3	DIO3	15	DIO7
4	DIO4	16	DIO8
5	EOI	17	REN
6	DAV	18	Signal Ground
7	NRFD	19	Signal Ground
8	NDAC	20	Signal Ground
9	IFC	21	Signal Ground
10	SRQ	22	Signal Ground
11	ATN	23	Signal Ground
12	Chassis Ground	24	Signal Ground

2.6.4 Setting the GPIB Address

Standard GPIB instrument controllers require that each controlled instrument on the GPIB bus have a unique address assigned. The Model 869 supports address selections in the range of 0 to 30.

When first powered on, the Mainframe sets its GPIB address to the value set by the rear panel GPIB **Address Selector** switches (see figure 2-3). Changing the setting of the selector switches changes the GPIB address as does entering a new value for the GPIB address via the

front panel Utility/GPIB menu. To see the value of the powerup address on the front panel display:

1. Push the front panel Power switch to **On**.
2. Press the **Select** key and the numeric keypad number **"0"** to select the Mainframe.
3. Press the **GPIB** softkey (**F2**) under the display.
4. Press the **adrs** softkey (**F4**) under the display. The display will show the present value of the Model 869 GPIB address.

Set the Model 869 GPIB power-up address with the **Address Selector** DIP switches on the rear panel (see figure 2-3).

Table 2-2. GPIB Address Switch Settings

GPIB Address	16	8	4	2	1
00	1	1	1	1	1
01	1	1	1	1	0
02	1	1	1	0	1
03	1	1	1	0	0
04	1	1	0	1	1
05	1	1	0	1	0
06	1	1	0	0	1
07	1	1	0	0	0
08	1	0	1	1	1
09	1	0	1	1	0
10	1	0	1	0	1
11	1	0	1	0	0
12	1	0	0	1	1
13	1	0	0	1	0
14	1	0	0	0	1
15	1	0	0	0	0
16	0	1	1	1	1
17	0	1	1	1	0
18	0	1	1	0	1
19	0	1	1	0	0
20	0	1	0	1	1
21	0	1	0	1	0
22	0	1	0	0	1
23	0	1	0	0	0
24	0	0	1	1	1
25	0	0	1	1	0
26	0	0	1	0	1
27	0	0	1	0	0
28	0	0	0	1	1
29	0	0	0	1	0
30	0	0	0	0	1

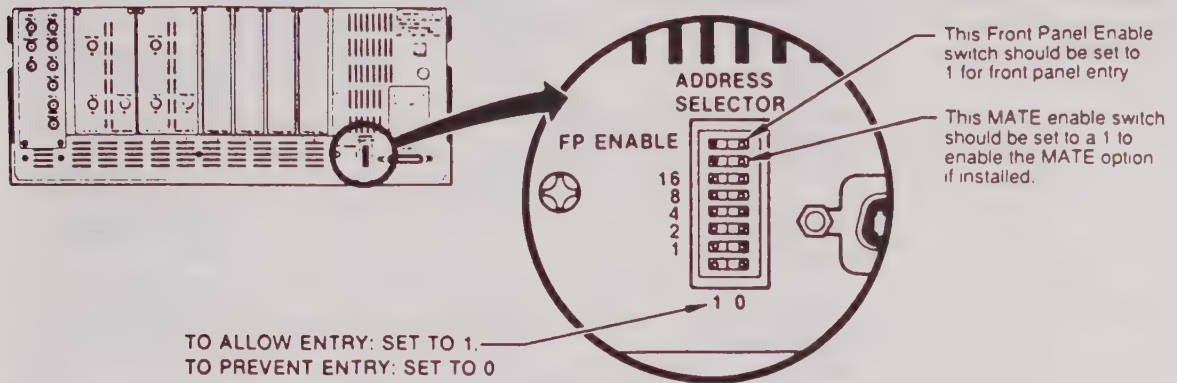


Figure 2-3. Rear Panel GPIB Address DIP Switch

Use table 2-2 to find the combinations of switch closures that correspond to the desired GPIB address. It is necessary to repeat step four above each time the rear panel Address Selector DIP switches are changed to have the display show the most recent address change.

The Model 869 GPIB address can be changed from the front panel if the "Front Panel Enable" switch shown in figure 2-3 is the "1" position. To change the GPIB address from the front panel:

1. Push the front panel Power switch to **On**.
2. Press the **Select** key and the numeric keypad number **"0"** to select the Mainframe.
3. Press the **GPIB** softkey (**F2**) under the display.
4. Press the **adrs** softkey (**F4**) under the display. The display will show the present value of the Model 869 GPIB address.
5. Rotate the **Cursor knob** counterclockwise or clockwise to decrement or increment the address. The

new GPIB address is the value displayed. This can also be achieved by entering value and then **Execute**.

2.7 MAINFRAME VERIFICATION

The Mainframe Verification Procedure given in table 2-4 tests the operation of the Model 869 Mainframe chassis components. (A similar test for checking the condition of the "Pulse Generator modules" can be found later in this section of the manual.)

2.7.1 Required Test Equipment

Table 2-3 lists the required test equipment for this procedure.

2.7.2 Checkout Verification Record

Table 2-5 following the checkout procedure is an operation test record that can be used to keep a permanent record of the test results.

Table 2-3. Required Test Equipment

Equipment	Qty	Specifications
Oscilloscope	1	Dual Channel. Vert Sens: 10 mV to 5V/DIV. Horiz Swp: 5 nS to 1 Sec/DIV. Input Imp: ≥ 1 M Ω or 50 Ω . Bandwidth: ≥ 100 MHz, ≥ 300 MHz preferred.
Terminations	3	BNC feedthrough. 5W (40W optional). 50 Ω impedance (75 or 93 Ω opt.)

Table 2-3. Required Test Equipment (Continued)

Equipment	Qty	Specifications
Coaxial Cables	3	One meter lengths. BNC male on both ends. RG-223/U type, 50 Ω (75 or 93 Ω opt.). 10 MHz minimum. Output: 50 Ω , 5 Vpp minimum
Signal Generator	1	Output Connection: BNC. Required Function: Square Wave. 10 MHz minimum.
Frequency Counter	1	

Table 2-4. Mainframe Verification Procedure

Step	Action	Test Set-ups and Action Responses
1	Power-up Test	
1-1	Perform the Power verification and connection steps in paragraph 2.6.1.	
1-2	Press the front panel Power switch to On . Unit has failed test if message at right does not appear.	----- WAVETEK Model 869 ----- sys Ver X.X.X
1-3	Run a Global Autocal. (Refer to section 3.10.2 for details).	
2	Beeper Test	
2-1	Press the following front panel keys in order.	----- utility ----- sys frtprnl time temp diag vers
2-2	Press the Select key followed by the numeric keypad number "0" .	
2-3	Press the Utility softkey (F1).	--- front panel --- sys beep view lite
2-4	Press the frtprnl softkey (F1).	
2-5	Press the beep softkey (F1).	beeper sys on off
		Front panel beeper can be turned on or off from this menu. The active menu selection will be in all caps.

Table 2-4. Mainframe Verification Procedure (Continued)

Step	Action	Test Set-ups and Action Responses
3	Display View Angle Test The display viewing angle can be adjusted to compensate for equipment height. The adjustment range is from 0 to 45 degrees.	<i>Each change in the setting of the viewing angle should result in a change in the display viewing angle (contrast).</i>
3-1	Press the following front panel keys in order.	
3-2	Select key and number 0 key	sys ----- utility ----- FRTPNL time temp diag vers
3-3	Utility F1	sys --- front panel --- BEEP view lite
3-4	FRTPNL F1	viewing angle: 0 sys --- front panel --- beep VIEW lite
3-5	View F2	viewing angle: 45 sys --- front panel --- beep VIEW lite
3-6	Rotate Cursor knob clockwise	viewing angle: 43 sys --- front panel --- beep VIEW lite
3-7	Press the down Cursor arrow twice.	viewing angle: 30 sys --- front panel --- beep VIEW lite
3-8	Enter value with keyboard. Press 3, 0, Execute .	

Table 2-4. Mainframe Verification Procedure (Continued)

Step	Action	Test Set-ups and Action Responses
4	Back-light Test	
4-1	Press the Select key and then the number 0 key. Press the following keys in order.	sys ----- utility ----- FRTPNL time temp diag vers
4-2	Utility F1	
4-3	FRTPNL F1	viewing angle: 30 sys --- front panel --- beep VIEW lite
4-4	Lite F3	sys backlight on off <i>Pressing either selection executes the selection and returns to the previous menu shown below.</i> sys --- front panel --- beep view LITE
5	Time Display Test	
5-1	Press the Select key and then the number 0 key. Press the following keys in order.	sys ----- utility ----- FRTPNL time temp diag vers
5-2	Utility F1	sys -- time -- - elapsed- set disp start disp stat
5-3	Time F2	
5-4	Time-disp F2	sys current time display on off
5-5	On — F1	sys 13:43:07 24 Jun 90 -- time -- - elapsed - set DISP start disp stat <i>Note: Might not be preset to the correct time and date from factory.</i>

Table 2-4. Mainframe Verification Procedure (Continued)

Step	Action	Test Set-ups and Action Responses
5-6	Press the Select key and then the number 0 key. Press the following keys in order.	9:46:58 24 Jun 90 sys ----- utility ----- frtpnl TIME temp diag vers
5-7	Utility F1	
5-8	Time F2	9:43:07 24 Jun 90 sys -- time -- - elapsed - set DISP start disp stat
5-9	Elapsed Disp F4	9:48:16 24 Jun 90 sys elapsed time display on off
5-10	On F1 Turn elapsed time off at this point, by pressing "select", "0", "utility", "time", "elapsed disp" and "off".	elapsed time is HHH:MM:SS sys -- time -- - elapsed- set disp start DISP stat <i>Shows the amount of elapsed time since the last time the start button was selected.</i>
6	Temperature Sensor Test	
6-1	Press the Select key and then the number 0 key. Press the following keys in order.	sys ----- utility ----- frtpnl TIME temp diag vers
6-2	Utility F1	
6-3	Temp F3	sys temp disp --- temp stats --- on off - max min clear
6-4	On F1	34 deg C sys temp disp --- temp stats --- ON off - max min clear
6-5	Off F2	sys temp disp --- temp stats --- on OFF - max min clear

Table 2-4. Mainframe Verification Procedure (Continued)

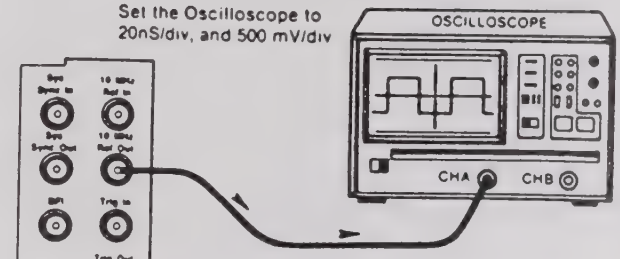
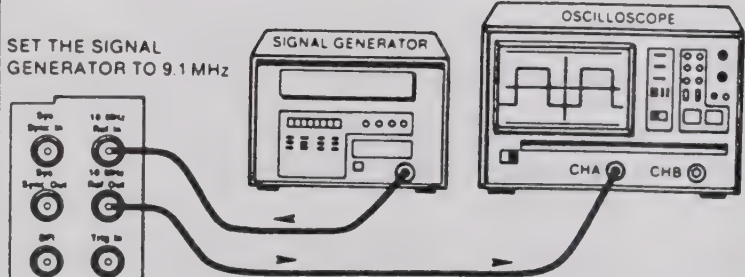
Step	Action	Test Set-ups and Action Responses
7	10 MHz Reference Test	
7-1	Connect the Model 869 rear panel 10 MHz Ref Out output to the oscilloscope Channel A input as shown at right.	Set the Oscilloscope to 20nS/div, and 500 mV/div 
7-2	If the oscilloscope Channel A input is not terminated with a 50Ω load, observe on the oscilloscope a 10 MHz, 5 Vp-p square wave with a rise/fall time of <10 ns.	
7-3	If the oscilloscope Channel A input is terminated with a 50Ω load, observe on the oscilloscope a 10 MHz, 2.5 Vp-p square wave with a rise/fall time of <10 ns.	
7-4	Set the signal generator to 9.1 MHz and connect its output to the 10 MHz Ref In BNC on the Model 869 back panel. Connect the oscilloscope to monitor the 10 MHz Ref Out .	SET THE SIGNAL GENERATOR TO 9.1 MHz  Set the Oscilloscope to 20nS/div and 500 mV/div.
7-5	Press the Select key and then the number 0 key. Press the following keys in order.	sys ----- system menu ----- util gpib config

Table 2-4. Mainframe Verification Procedure (Continued)

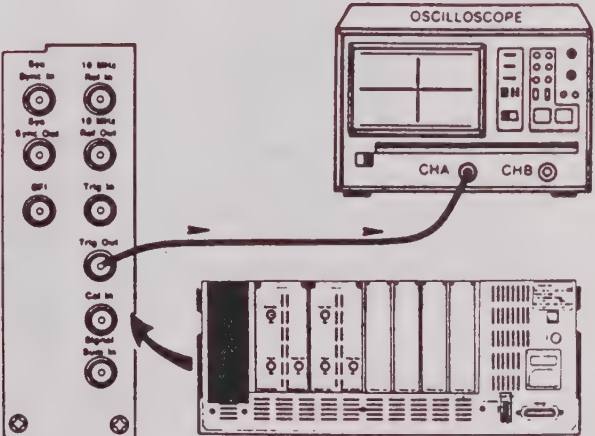
Step	Action	Test Set-ups and Action Responses
7-6	Config F3	sys -trig- config -- -sync mode- slave INDEP -10MHz int Ref- ext
7-7	Select internal reference (F5), and observe the 10 MHz signal on the oscilloscope.	sys -trig- config -- -sync mode- slave INDEP -10MHz INT Ref- ext
7-8	Try to select the external reference (F6). An error message will appear.	sys External reference not present -trig- config -- -sync mode- slave INDEP -10MHz int Ref- EXT
8	System Trigger Test	
8-1	Press the Select key and then the number 0 key. Press the following keys in order.	
8-2	Config F3	
8-3	Connect the Trig Out BNC on the Model 869 rear panel to the oscilloscope Channel A input as shown at right.	 The diagram illustrates the connection for the System Trigger Test. On the left is the rear panel of the Model 869, showing various input and output ports. A BNC cable is connected from the 'Trig Out' port to the 'CHA' (Channel A) input of an oscilloscope. The oscilloscope is shown with its screen and controls. The Model 869 panel also shows other ports like 'Sync', '10 MHz Ref', 'Trig In', 'Cal In', and 'Signal Switch In'.

Table 2-4. Mainframe Verification Procedure (Continued)

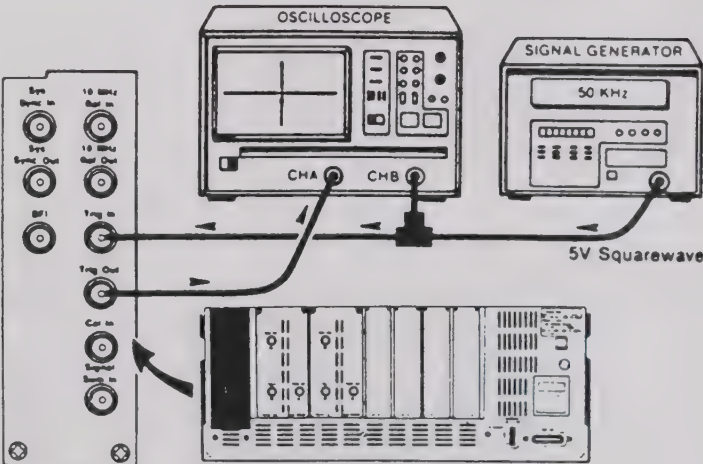
Step	Action	Test Set-ups and Action Responses
8-4	Press the following keys:	
8-5	Int F5	sys - trig- - sync mode- - 10MHz Ref- config - slave INDEP INT ext
8-6	Input F1 and Intern F2	trigger frequency: 10.0 Q kHz sys --- trigger input --- off INTERN extern
8-7	Press the numeric keys: 1, 0, 0, Exponent, 3, Execute	trigger frequency: 100. Q kHz sys --- trigger input --- off INTERN extern Oscilloscope shows 100 kHz square wave.
8-8	Set the signal generator to 50 kHz and feed this frequency into the Trig In input BNC on the rear panel of the 869 while monitoring this square wave on one channel of the oscilloscope. Connect the Trig Out output BNC of the 869 to the other input channel of the oscilloscope. See this test setup shown at the right. Set the signal generator amplitude for a 0 to 5V squarewave.	
8-9	Press:	sys - external trig mode- - slope - normal delay events level pos NEG
8-10	Extern F3	

Table 2-4. Mainframe Verification Procedure (Continued)

Step	Action	Test Set-ups and Action Responses
8-11	Normal F1	sys -external trig mode- - slope - NORMAL delay events level pos neg
8-12	Pos F5	sys -external trig mode- - slope - NORMAL delay events level POS neg
8-13	Neg F6	sys -external trig mode- - slope - NORMAL delay events level pos NEG <i>Observe that Channel A and Channel B of oscilloscope are 180 out of phase.</i>
8-14	Pos F5	sys -external trig mode- - slope - NORMAL delay events level POS neg
8-15	Events F3	trigger delay events: 2 sys -external trig mode- - slope - normal delay EVENTS level POS neg
8-16	Enter 4, Execute	trigger delay events: 4 sys -external trig mode- - slope - normal delay EVENTS level POS neg <i>NOTE: The frequency of the system trigger is one-fourth that of the signal generator frequency on the oscilloscope.</i>
8-17	Press the Select key and then the number 0 key. Press the following keys in order.	
8-18	Config F3	sys -trig- -sync mode- -10MHz Ref- config -- slave INDEP INT ext
8-19	Config F1	sys --- trigger config --- off intern EXTERN

Table 2-4. Mainframe Verification Procedure (Continued)

Step	Action	Test Set-ups and Action Responses
8-20	Extern F3	trigger delay events: 4 sys -external trig mode- - slope - normal delay EVENTS level POS neg
8-21	Delay F2	trigger delay time: 100nS sys -external trig mode- - slope - normal DELAY events level POS neg
8-22	5, Exponent, 6, ±, Execute <i>Note: trig delay is only allowable while input signal is High. This delay cannot be less than input width.</i>	trigger delay time: 5.0 uS sys -external trig mode- - slope - normal DELAY events level POS neg Verify on the oscilloscope a 5 μsec delay between the Sys Trig In input signal leading edge and the 869 Sys Trig Out output pulse.
9	System Sync Test	
9-1	Set the signal generator output for a 1 MHz squarewave. Connect the output to the 869 Sys Sync In connector on the rear panel. Connect the 869 Sys Sync Out to the oscilloscope. • The test setup is shown at right.	
9-2	Press the Select key and then the number 0 key. Press the following keys in order.	- trig- - sync mode- - 10MHz Ref- config -- slave INDEP INT ext

Table 2-4. Mainframe Verification Procedure (Continued)

Step	Action	Test Set-ups and Action Responses
9-3	Conflg F3	sys -trig- config -sync mode- -- slave INDEP -10MHz INT Ref- ext
9-4	Slave F3	sys -trig- config -sync mode- -- SLAVE indep -10MHz INT Ref- ext <i>The Model 869 is now configured as a slave to the external Sys Sync In input from the signal generator. This signal is mirrored to the 869 System Sync (SSYNC) bus and also appears at the 869 Sys Sync Out BNC and consequently on the oscilloscope.</i>
9-5	Indep F4	sys -trig- config -sync mode- -- slave INDEP -10MHz INT Ref- ext <i>Observe the absence of any signal on the oscilloscope; there is no activity on the System Sync (SSYNC) bus.</i>
9-6	Test complete. Turn the Power switch to Standby .	

Table 2-5. Mainframe Resource Verification Test Record

Step	Test	Test Results
1	Power-up Test	
2	Beeper Test	
3	Display Viewing Angle Test	
4	Back-light Test	
5	Time Display Test	
6	Temperature Sensor Test	
7	10 MHz Reference Test	
8	System Trigger Test	
9	System Sync Test	

2.8 MAINFRAME REAR PANEL

2.8.1 System Connector and Switch Functions

All connections are located on the rear panel. Figure 2-4 shows the 869 System Mainframe rear panel with typical modules installed. Table 2-6 describes the function of each mainframe connection. For module connections, refer to the module installation paragraphs.

2.8.2 System Connector Electrical Specifications

Refer to table 2-7 before making any connections to the Model 869. Do not exceed the specifications indicated.

CAUTION

Exceeding the specifications shown in table 2-7 may cause damage to the Model 869.

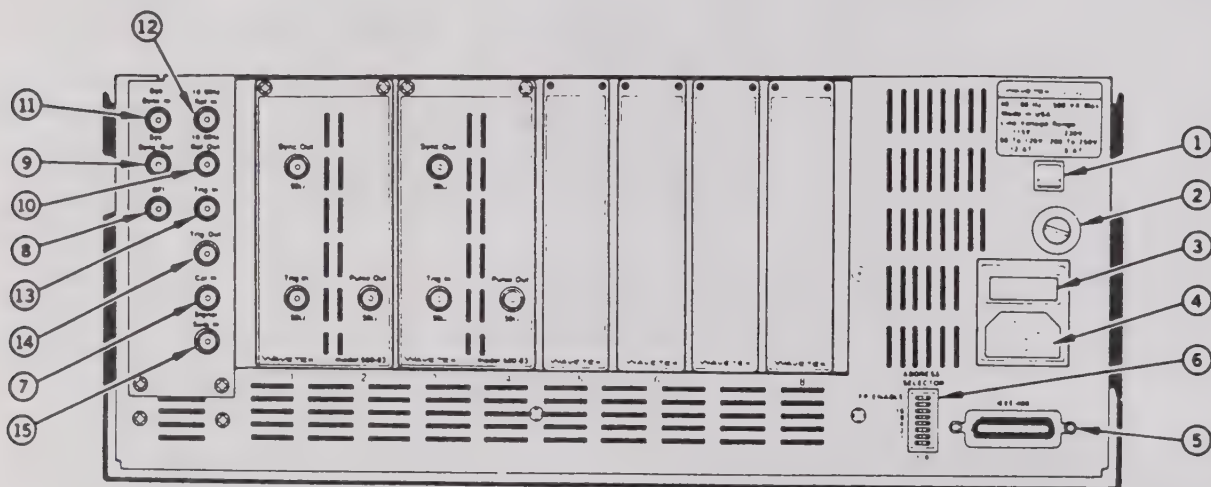


Figure 2-4. Rear Panel Switches and Connections.

Table 2-6. System Connector/Switch Functions

Label/Name	Function
1. Selector Voltage	Allows the user to select the correct line voltage (110 Vac or 220 Vac).
2. Fuse	Limits the input current to the power supply module.
3. Power Switch	Push the "I" side of the rocker switch to power the Model 869. Push the "O" side of the switch to disconnect operating power.
4. IEC Power Connection	Input connection for the instrument line voltage (110 Vac or 220 Vac).
5. IEEE-488	Allows connection of the external GPIB bus to this standard IEEE-488 connector.
6. Address Selector	Sets the GPIB address for the Model 869.
7. Cal In	Provides a reference voltage used during the manual calibration of the internal DVM.
8. DFI	(Discrete Fault Indication) Connected to a floating set of relay contacts that open when the Model 869 is off, when a microprocessor failure occurs, or when the Model 869 internal temperature reaches 75°C.

Table 2-6. System Connector/Switch Functions (Continued)

Label/Name	Function
9. Sys Sync Out	The signal appearing on the Mainframe System Sync bus (SSYNC) is mirrored to this output connection. Other instrumentation operation can be synchronized from this signal.
10. 10MHz Ref Out	The Model 869 internal 10 MHz reference frequency is mirrored to this output connection.
11. Sys Sync In	The signal appearing at this input connection is mirrored to the Mainframe System Sync (SSYNC) bus.
12. 10 MHz Ref In	An external reference 10 MHz signal appearing at this input can be selected for the Model 869 internal 10 MHz reference frequency.
13. Trlg In	This input provides the trigger to the Mainframe System Trig bus and can be used to trigger modules in the chassis.
14. Trlg Out	The System Trigger (STRIG) signal is mirrored to this output. Other equipment operation can be triggered by this System Trigger.
15. Sum Bus	This external signal input provides access to the internal analog sum bus. The summed signal will appear at the selected modules output if that modules sum feature has been selected. (Not used by Pulse Generator modules.)

Table 2-7. Mainframe Signal Connector Specifications

Connection	Type	Voltage Limits	Impedance	Protection	Other Specification
Sys Sync In	Input	0 to +1V into 1k Ω	>1 k Ω	$\pm 5V$	
Sys Sync Out	Output	0.2 to +1V into 50 Ω	50 Ω	Short Circuit	Rise/Fall time: <10 ns
DFI	Output		Contact Resistance $\leq 0.2\Omega$	N/A	No Fault: Open Ckt Fault: Short Ckt
10 MHz Ref Out	Output	2 TTL $\leq 0.2V, \geq 2.4V$	50 Ω	Short Circuit	
10 MHz Ref In	Input				10 MHz $\pm 5\%$
Trlg In	Input	1 Vp-p to 20 Vp-p	>1 k Ω	$\pm 15V$	Rise/Fall: < 50 ms Resolution: 0.1V Frequency: <20 MHz for normal trigger Delayed and Event: <5 MHz
Trlg Out	Output	TTL	50 Ω	Short	Rise/Fall time: <10 ns
Signal Sum In	Input	± 5 Vp-p	>50 Ω	$\pm 15V$	Bandwidth: >10 MHz
Cal In	Input	± 4 Vdc ± 0.1 mv	>1 k Ω	$\pm 15V$	

2.9 MODULE INSTALLATION

The following steps describe how to install Model 680-03 Pulse Generator modules into the Model 869 Mainframe chassis:

NOTE

The following installation procedure can be used when installing a Model 680-03 Pulse Generator into a Model 680 Mainframe or a Model 869 Mainframe. If you are installing a Model 680-03 Pulse Generator module into a Model 680 Mainframe refer to the Model 680 Mainframe Operator's Manual or the Model 680-03 Pulse Generator Operator's Manual. The Module Initial Checkout following the module installation paragraph in this manual pertains only to the Model 869 Mainframe and should not be used with a Model 680 Mainframe.

1. Remove the two screws from the rear of the Mainframe top cover and then slide cover back and off.
2. Place the module into the channel slots as illustrated in figure 2-5*. When inserting the module into the slots ensure the module guides slide into the top chassis alignment guides at either end of the module. Before setting the module in its channel slot visually verify correct positioning.

** Blank modules must be used in nonfunctional slots for bus continuity, radiation control and air path control, as seen in figure 2-6.*

3. Replace the top cover and fasten with two screws at the rear lip of the top cover.

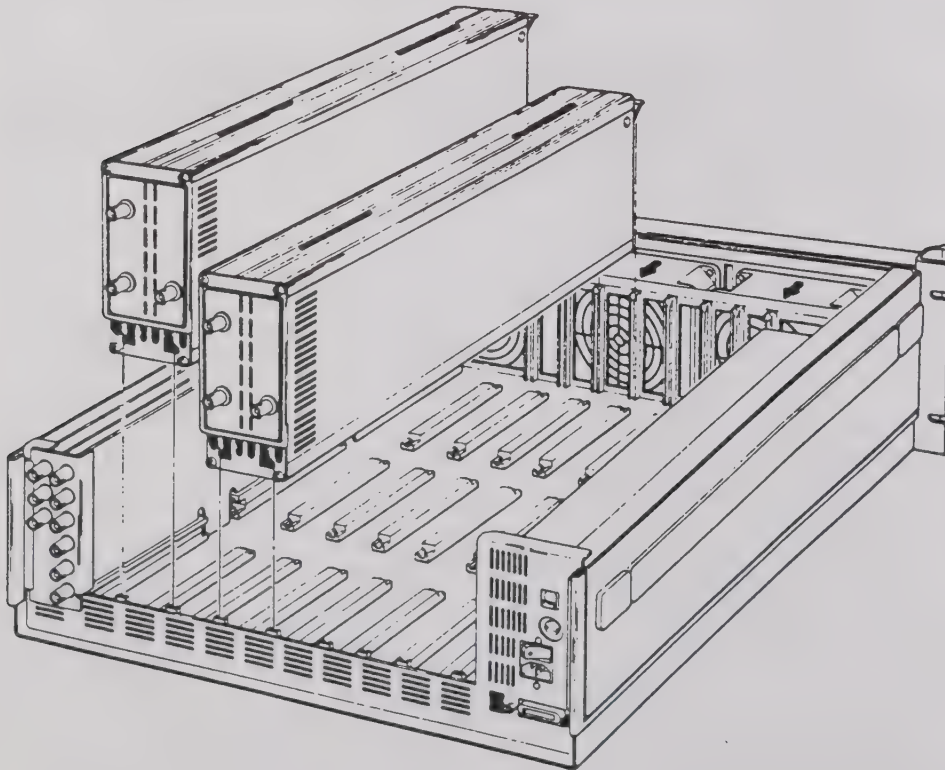


Figure 2-5. Module Installation

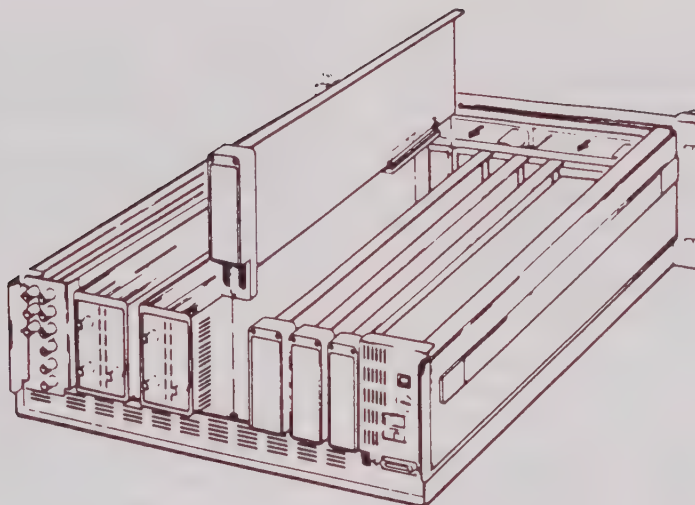


Figure 2-6. Blanking Module Placement

2.10 MODULE INITIAL CHECKOUT

The following paragraphs provide the information required to prepare, turn-on, and quick check the Pulse Generator module in the local mode. All of the front panel controls, keys, and displays are described in detail in Section 3 of this manual. Information on operation in the remote mode of operation can also be found in Section 3 of this manual.

2.10.1 Checkout Test Equipment

Refer to table 2-8 for a list of the test equipment required to perform an initial checkout of the Pulse Generator module while installed in a Model 869 Mainframe. The Mainframe does not need to have any other working modules in it, but the empty slots must have a blank module installed. For the purpose of illustration in this section, the module of interest is installed in slots 1 and 2 ("CH1") of a Model 869 Mainframe.

Table 2-8. Initial Checkout Test Equipment

Equipment	Qty	Description
Model 869 Mainframe	1	1100-00-3417
Trigger signal source	1	Wavetek Model 680-03 (in an 869 mainframe), or any bench pulse generator operating to 50 MHz or higher.
Oscilloscope	1	General Purpose, with >250 MHz BW
Coaxial Cables	2	50Ω w/BNC's

2.10.2 Preparation for Use

WARNING

The Model 869 Mainframe is equipped with a three-wire power cable. This cable, when connected to a grounded AC power receptacle, grounds the instrument front panel and cabinet. Do not use any extension cords or AC adapters without a ground.

1. On the mainframe rear panel, verify that the red voltage selector switch (in the upper right corner) is set to the correct voltage for the power source being used.
2. Verify that a standard U/L and CSA approved three-wire power cable is available to connect the Mainframe to the AC power source.
3. Verify that the mechanical installation of the Pulse Generator module was performed correctly as detailed in paragraph 2.9.
4. Verify that the Mainframe front panel Power switch is set to the "Standby" position.

2.10.3 Turn-On and Checkout Procedure

1. Connect the power cable from the Model 869 Mainframe rear panel to the AC power source.
2. Set the Mainframe Power switch to the "On" position. The front panel display should appear as shown in the following illustration.

```

----- WAVETEK Model 869 -----
                V1.0.0

```

3. Press the Channel Select key. The Model 869 front panel display will provide a menu list similar to that shown below of all of the modules physically installed in the Model 869 Mainframe.

```

1: PULSE GEN master
2:
3:
4:

```

4. Select the number from the list that represents the channel number for the Pulse Generator module. Enter that number on the numeric keypad. For example, if the module is installed in slots number 1 and 2, press numeric key 1 to select that module. A new menu will appear giving the top level selections for channel one. The "ch1" in the upper right hand corner indicates that the module located in slots one and two of the mainframe is selected.

```

PER:1.0000mS  LE:1.00nS  square  ch1
DLY:-----  TE:1.00nS  continuous
WID:-----  UL:500.mV  master
TRGLVL:1.6V  LL:-500.mV off,norm

```

The remainder of the display gives the "reset" default values for the selected module.

5. Press the Cal/Test key. A new display menu will appear that gives three choices using the function keys F1 thru F3.

```

ch1
----- pulse generator cal/test menu -----
autocal sltst qcal

```

CAUTION

The AutoCal function of the Module Cal/Test key should not be used to check-out the Instrument as it will delete all former module calibration information from the Mainframe memory.

- F1 (autocal)** Perform automatic calibration of the channel(s) with data saved to non-volatile RAM in the Mainframe.
- F2 (sltst)** Performs Self-test of the channel(s) and/or mainframe.

- F3 (qcal)** Performs quick automatic calibration of the channel(s) with data **not** saved in the Mainframe non-volatile RAM.

6. Press the F2 (sltst) function key to select the Self-test function. New menu selections will replace the existing menu selections as shown below.

```

ch1
---- pulse generator selftest menu ----
start abort status

```

7. Press F1 (start) to start the internal Self-test function. The front panel display will indicate that the instrument is cycling through Self-test, displaying each item as it is being tested.

```

selftest in progress 1 min. required  ch1
testing amplitude level
---- pulse generator selftest menu ----
start abort status

```

When testing is complete with no errors, the display will indicate the status as shown below.

```

selftest status: 0  ch1
---- pulse generator selftest menu ----
START abort status

```

NOTE

If any part of the Self-test fails to pass, the module should be sent to a repair shop. If this occurs during an incoming receiving inspection, the module should be returned to the supplier or to Wavetek for warranty repair or replacement.

8. Press the Cal/Test key followed by the F3 qcal key. The front panel display will produce one of the following messages.

a) If the module has not been run through a successful AutoCal with the calibration data stored in the system, the unit will not be able to run a Quick Cal. The following message will be displayed. Perform an AutoCal before continuing.

```

quickcal not performed because  ch1
autocal has not been performed
---- pulse generator menu (V1.0.0) ----
mode func levels timing output confg

```

b) If the module has been calibrated, "Quick Cal" will start. This means that the system has initiated a quick calibration of the selected module. Since the module parameters have not been changed since the initial turn-on, the default parameters will be the ones that are quick calibrated.

```

quickcal in progress, 20 secs req'd      ch1
      calibrating delay
---- pulse generator cal/test menu ----
autocal  sltst  QCAL
  
```

9. Connect the channel one pulse output to the digitizing oscilloscope listed in table 2-8, using the configuration shown in figure 2-7.

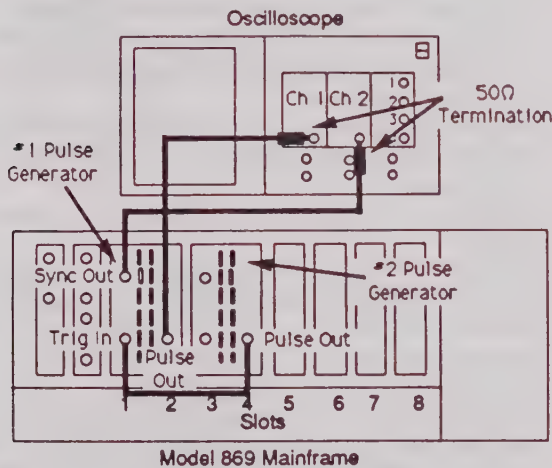


Figure 2-7. Timing Measurement Hookup

10. Press the Output key to display the Output menu.
11. Observe that both the Sync Out and Pulse Out signals of the Pulse Generator are "Off" as no waveforms are seen on oscilloscope display.
12. Press the "On" function key F5 key from the Output key menu..
13. With the "Output" function "On" the front panel display will indicate output status in the upper left-hand corner. A "zero" indicates that the output is "Off" and a "one" indicates that the output is "On". Verify that both Pulse Out and Sync Out signals are present on the oscilloscope display.

```

output: 1                                ch1
----- pulse output -----
off  ON  —  norm  compl  —
  
```

14. Set the oscilloscope trigger for Ch.2 and verify that a waveform from the Sync Out connector with the parameters shown in the following list is present on Ch.2 of the oscilloscope.

Function	Squarewave
Mode	Continuous
Frequency	1 kHz
Upper Level	≥1V
Lower Level	<0.2V

15. Verify that a waveform from the Pulse Out connector with the parameters shown in the following list is present on Ch.1 of the oscilloscope.

Function	Squarewave
Mode	Continuous
Frequency	1 kHz
Upper Level	+500 mV
Lower Level	-500 mV

16. Set the second Pulse Generator or external Generator parameters to provide a Trig In signal as shown in the following list.

Function	Pulse
Mode	Continuous
Width	1 μs
Frequency	2 kHz
Upper Level	+1 V
Lower Level	0 V

NOTE

A second Pulse Generator (in an 869), or an external pulse generator can be used to provide the Trig In signal.

17. Change the channel one module parameters as shown in the following list.

Function	Pulse
Mode	Trigger
Trig Input	Extern
Trigger Level	0.5 V
Pulse Width	2 μs

18. Verify with the oscilloscope that a waveform having the parameters shown in the following list is present at the channel one Pulse Out connector.

Function	Pulse
Frequency	2 kHz
Pulse Width	2 μs
Upper Level	+500 mV
Lower Level	-500 mV

2.11 MODULE VERIFICATION

These paragraphs provide additional tests for a more thorough testing of the Pulse Generator. Performance verification tests the operation of all selectable parameters and input/output connectors, and verifies correct operation within each major specification. This verification is necessary when the module has been repaired, has a problem that was not identified by the AutoCal or Self-test programs, or requires periodic maintenance.

2.11.1 Required Test Equipment

Table 2-9 lists the required test equipment. Manufacturer model numbers are given as a guide but any equipment of equal or better performance can be used. Care should be taken to use precision cabling and terminations so that pulse quality is not degraded.

Table 2-9. Required Test Equipment

Equipment	Qty	Specifications
GPB Instrument Computer	1	Optional. GPB compatible to IEEE Std 488-1978.
Mainframe Chassis	1	Wavetek Model 869 Mainframe or equivalent.
Pulse Signal Source	1	Wavetek Model 680-03 or any bench pulse generator providing pulses to above 50 MHz.
Frequency/Time Interval Counter	1	HP-5334A, or equivalent.
Digital Multimeter	1	Datron Model 1062, or equivalent.
Oscilloscope, Digitizer	1	Tektronix 11402, or 11402A with 2 11A72 vertical amplifiers or any dual channel scope with >1 GHz BW and Ext Trig Input.
Terminations	2	Tektronix 011-0129-00: 50 Ω , 0.1%, 11 Vrms, or equivalent.
Attenuators	1	Narda 766-20: 50 Ω , 20 dB, 5.5 Watts, or equivalent.
Coaxial Cables	3	RG223/U, 50 Ohms, 4 ft lengths with BNC male both ends.

2.11.2 Test Record

Table 2-3 can be used to record a permanent record of the module test or it can be used as a master to generate periodic maintenance record sheets.

For the following tests, the module parameters can be set with front panel controls or with a GPIB compatible controller.

2.11.3 Pulse Definitions

The following is a list of definitions pertaining to pulse waveforms as used in this manual (refer to figure 2-4).

- Pulse width (pulse duration) is the time duration measured between the 50% points of the leading and trailing transitions of the waveform.
- Pulse delay for single pulse is measured from the 50% point on the leading edge of the Sync Out waveform to the start (0% point) of the leading edge on the Pulse Output waveform.
- Double Pulse delay is the time difference between the 0% point on the leading transition of both the first and second pulses.
- Squarewave delay is always 0, and not programmable.
- The transition times (transition duration of the leading and trailing edges) of pulses used in this pulse generator are measured from the 10% to 90% points on the waveform, except where it is specified as from the 20% to 80% points.
- Pulse aberrations are measured with respect to the 0% (baseline) or the 100% points (top line) on the waveform. Aberrations are defined as a percentage of the peak-to-peak waveform amplitude.
- Upper level is the top line magnitude of a normal (positive) pulse and is the base line magnitude of a complementary (negative) pulse.
- Lower level is the base line magnitude of a normal (positive) pulse and is the top line magnitude of a complementary (negative) pulse.

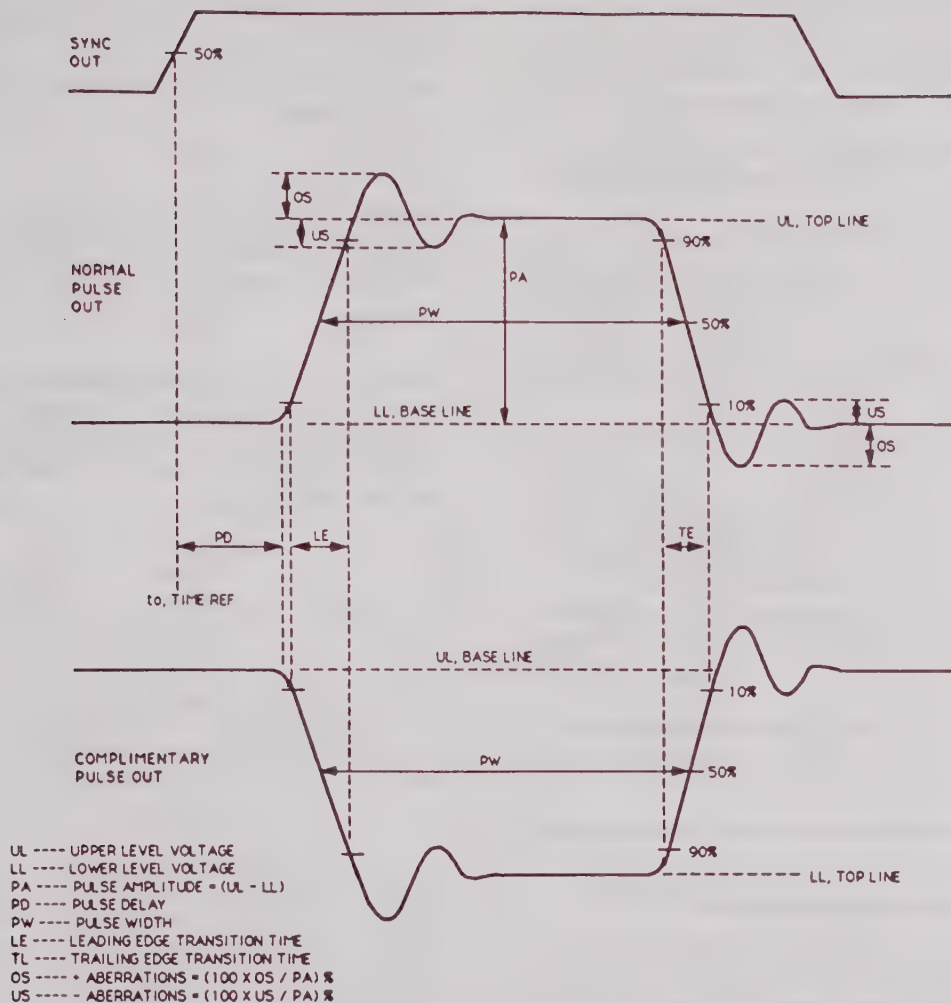


Figure 2-8. Pulse Waveform Terms and Definitions

2.11.4 Firmware Version Check

The Model 680-03 Pulse Generator will work with all versions of firmware in the Model 869 Mainframe. If the Model 680 Mainframe is used to operate the Pulse Generator. Refer to the appropriate paragraphs in the Model 680-03 Operator's Manual for information.

To check for the current version of firmware in the Model 869, perform the following steps:

1. Connect the Model 869 Mainframe to the AC power source.
2. Turn the Mainframe **Power** switch to "On".
3. The System VME board firmware version will be displayed.
3. Press the following key combination to display the System Ref/Cal board firmware version:
 Channel Select,
 0 (zero),
 Util (F1),
 Refcal (F2),
 and vers (F6).
4. Press the following key combination to display the installed modules firmware versions:
 Channel Select,
 0 (zero),
 Util (F1),
 and vers (F5).

2.11.5 Verification Information

The performance verification test procedures will guide a user through the performance verification of the Pulse Generator module. The following points must be noted:

- The verification tests within each group of tests should be performed in the order given to avoid possible measurement errors.
- The operation and locations of all of the mainframe front panel controls and keys associated with the Pulse Generator module are contained in Section 3 of this manual.
- Parameters can be set with the mainframe front panel keys and controls, or they can be programmed with a GPIB controller.
- When used in the verification, the Model 680-03 Pulse Generator module (UUT) is assumed to be installed in slots #1 and #2 of the mainframe. If a second Model 680-03 Pulse Generator is available, it can be installed in slots #3 and #4. The remaining empty slots must be filled with Wavetek blank modules.
- Both the required test equipment and the mainframe (and module) must be turned on for at least 30 minutes at an ambient temperature in the range of +15°C to +35°C.
- The accuracy of the performance verification tests is also dependent on a properly calibrated and fully operational mainframe.

2.12 PERFORMANCE VERIFICATION PROCEDURES

2.12.1 Frequency Accuracy Test

This test is designed to verify the frequency accuracy of the Pulse Generator module and to check the frequency setability to five significant digits.

1. Interconnect the required test equipment as shown in figure 2-9.

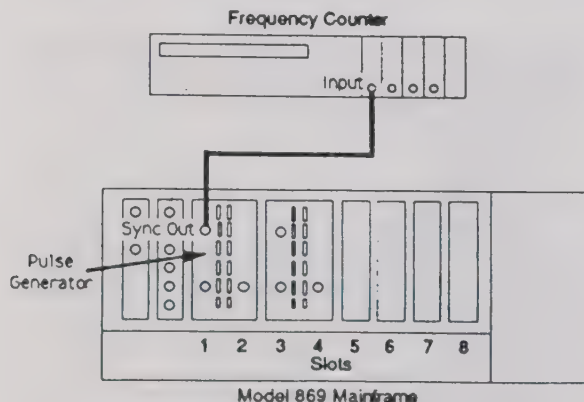


Figure 2-9. Frequency Accuracy Test Hookup

2. Set the Frequency/Time Interval Counter to measure the frequency at the Sync Out connector of the pulse generator module.
3. Set the Mainframe (Channel Select 0) to the following parameters:

Reset: Soft

4. Reset channel 1 (Channel Select 1) pulse generator module to its defaults using the "Reset" key, change the following parameters, then press Execute:

Output: On

5. Set the channel one module to each of the following frequencies listed below and record the Counter readings in table 2-10. Each of the measured values must fall within the minimum and maximum values shown in the table.

200.0 MHz
49.0 MHz
12.0 MHz
4.9256 MHz
1.2499 MHz

2.12.2 Operating Mode Tests

These tests are used to verify that the six different modes of operation are selectable and fully functional.

NOTE

A separate manual trigger is optional. By performing the Burst mode test successfully, it can be inferred that the manual trigger is fully functional. The Mainframe is required to service a manual trigger either from the front panel or from the GPIB and ultimately generate a trigger to the module.

Continuous Mode

1. Interconnect the required test equipment as shown in figure 2-7.
2. Reset the channel one pulse generator module to its defaults, change the following parameters, then press Execute:

Function: Single Pulse
Pulse Width: 1 μ s
Output: On

3. Set the oscilloscope to trigger on Ch.2 and adjust for a stable waveform.
4. Observe the oscilloscope display for correct waveform characteristics on Ch.1 and Ch.2 as shown in the following:

Oscilloscope Ch.1 with Pulse Out signal.

Function: Single pulse
 Frequency: 1 kHz
 Upper Level: +0.5V
 Lower Level: -0.5V

Oscilloscope Ch.2 with Sync Out signal.

Function: Squarewave
 Frequency: 1 kHz
 Upper Level: > +1V
 Lower Level: < 0.2V

Triggered (low freq) Mode

1. Interconnect the required test equipment as shown in figure 2-10.

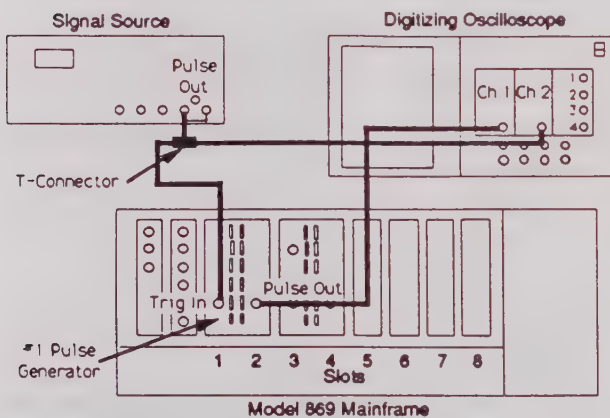


Figure 2-10. Triggered Mode (min) Hookup

NOTE

Both the Pulse Generator Trig Input and the oscilloscope input are 50 Ω input impedance. Most pulse generators are able to drive two 50 Ω loads (25 Ω total). If a high impedance oscilloscope input is used, move the T-connector to the oscilloscope input connector.

2. Set the signal source (external pulse generator or channel two pulse generator) to the following parameters:

Function: Squarewave
 Frequency: 2 kHz
 Upper Level: +1V
 Lower Level: 0.0V
 Output: On

3. Reset the channel one module under test to its

defaults, change the following parameters, then press Execute:

Mode: Triggered
 Trig Level: 0.5 V
 Function: Single Pulse
 Pulse Width: 1 μ s
 Output: On

4. Set oscilloscope to trigger on Ch.2 and adjust for a stable waveform.
5. Observe the oscilloscope display for correct waveform characteristics on Ch.1 and Ch.2 as shown in the following:

Oscilloscope Ch.2 with Trig In signal.

Function: Squarewave
 Frequency: 2 kHz
 Upper Level: +1V
 Lower Level: 0.0V

Oscilloscope Ch.1 with Pulse Out signal.

Function: Single pulse
 Frequency: 2 kHz
 Pulse Width: 1 μ s
 Upper Level: +0.5V
 Lower Level: -0.5V

Triggered (high freq) Mode

1. Change the setting of the external pulse generator (or channel two module) to as follows:

Frequency: 50 MHz

2. Change the parameters of the channel one pulse generator to the following:

Mode: Trigger Mode
 Pulse Delay: 0.0 ns
 Pulse Width: 5.0 ns

3. With the oscilloscope still triggered on Ch.2 adjust the display for a stable waveform.
4. Observe the oscilloscope for the correct waveform characteristics on Ch.1 and Ch.2, 1 cycle of a pulse for each cycle of trigger input signal, as in the following list:

Oscilloscope Ch.1 with Pulse Out signal.

Frequency: 50 MHz
 Pulse Width: 5.0 ns
 Upper Level: +0.5V
 Lower Level: -0.5V

Oscilloscope Ch.2 with Trig In signal.

Function: Squarewave
Frequency: 50 MHz
Upper Level: +1V
Lower Level: 0.0V

Burst Mode

1. Reset the external pulse generator as follows:

Frequency: 1 MHz

2. Change the parameters of the Model 680-03 Pulse Generator to the following:

Mode: Burst
Burst Count: 2
Frequency: 10 MHz
Pulse Width: 40 ns

3. Change the oscilloscope to trigger on an external trigger and adjust for a stable waveform.
4. Observe the oscilloscope for the correct waveform characteristics on Ch.2 and Ch.1, 2 cycles of a single pulse for each cycle of trigger input signal, as in the following list:

Oscilloscope Ch.2 with Trig In signal.

Function: Squarewave
Frequency: 1 MHz
Upper Level: +1V
Lower Level: 0.0V

Oscilloscope Ch.1 with Pulse Out signal.

Function: 2 cycles of a single pulse for every input trigger.
Frequency: 10 MHz, burst of 2 and more.
Pulse Width: 40 ns
Upper Level: +0.5V
Lower Level: -0.5V

5. Change the burst count of the Pulse Generator from 2 to 3, to 4 etc., and observe that the number of cycles for each trigger input agrees with settings.
6. Set burst count to 4 and perform the Sync Mode Select Test before continuing to test the other Pulse Generator modes.

Sync Mode Select

This test is used to verify that the desired Sync Out mode of operation can be selected. It is useful when the Pulse Generator is operating in the Gated or Burst Modes.

1. Continue from Step 5 of Burst Mode operation.
2. Observe that the signal at Sync Out connector has the same duty cycle as the signal at Pulse Out

connector. In this case, it is a burst of 4 pulses.

3. Select "Sync" from the Config menu. The display will show three menu key labels: off, clock, and gate.
4. Press the **F1** key (off) and observe that the Sync Out connector relay opens disconnecting the output and that no signal are present.
5. Press the **F3** key (gate) to close the Sync Out relay connector and observe that the sync signal is present again. But this time, the sync signal remains "high" while the Pulse Out connector is generating pulses. The output is "low" if pulses stop.
6. Press the **F2** key (clock) to return to the original setup.

Sync Gated Mode

1. Change the parameters of the external pulse generator as follows:

Frequency: 50 kHz
Function: Single pulse
Pulse width: 2.5 μ s

2. Change the parameters of the Model 680-03 Pulse Generator to the following:

Mode: Sync Gated
Frequency: 1 MHz
Function: Single Pulse
Pulse Width: 400 ns

3. Change the oscilloscope to trigger on Ch.2 and adjust for a stable waveform.
4. Observe the oscilloscope for the correct waveform characteristics on Ch.1 and Ch.2. The Ch.1 display is a burst of pulses 3 to 4 cycles. If the pulse width of the external pulse generator is increased gradually from 3.5 μ s to 6 or 7 μ s, the number of pulses in each burst is also increased, one complete cycle at a time, as in the following lists:

Oscilloscope Ch.2 with Trig In signal.

Function: Single pulse
Frequency: 50 kHz
Pulse width: Vary from 3.5 μ s to 7 μ s
Upper Level: +1V
Lower Level: 0.0V

Oscilloscope Ch.1 with Pulse Out signal.

Function: Single pulse
Frequency: 1 MHz, burst
Pulse Width: 400 ns
Burst count: vary from 3 to more cycles, always a complete cycle
Upper Level: +0.5V
Lower Level: -0.5V

Async Gated Mode

1. Change the parameters of the channel one pulse generator to the following:

Mode: Async Gated

2. Observe the oscilloscope for the correct waveform characteristics on Ch.2 and Ch.1. The Ch.1 display is a burst of pulses 3 to 4 cycles. If the pulse width of the external pulse generator is increased gradually from 3.5 μ s to 6 or 7 μ s, the number of pulses in each burst is also increased, but the last cycle of pulse is not always a full cycle, as in the following lists:

Oscilloscope Ch.2 with Trig In signal.

Function: Single pulse
Frequency: 50 kHz
Pulse width: Vary from 3.5 μ s to 7 μ s
Upper Level: +1V
Lower Level: 0.0V

Oscilloscope Ch.1 with Pulse Out signal.

Function: Single pulse
Frequency: 1 MHz, burst
Pulse Width: 400 ns
Burst count: vary from 3 to more cycles,
the last cycle is not always
a complete cycle
Upper Level: +0.5V
Lower Level: -0.5V

External Width Mode

1. Change the parameters of the channel one pulse generator to the following:

Mode: External width

2. Observe the oscilloscope for correct waveform characteristics on Ch.1 and Ch.2. The pulse timing of Ch.1 display is identical to the trigger input signal on Ch.2. If the pulse width of the trigger waveform is varied from 3.5 μ s to 7 μ s, the Pulse Out waveform on Ch.1 varies the same, as in the following lists:

Oscilloscope Ch.2 with Trig In signal.

Function: Single pulse
Frequency: 50 kHz
Pulse width: Vary from 3.5 μ s to 7 μ s
Upper Level: +1V
Lower Level: 0.0V

Oscilloscope Ch.1 with Pulse Out signal.

Function: Single pulse
Frequency: 50 kHz
Pulse width: Vary from 3.5 μ s to 7 μ s
Upper Level: +0.5V
Lower Level: -0.5V

2.12.3 Burst Count Test

This test is used to verify the setability and the accuracy of the burst counter.

1. Interconnect the required test equipment as shown in figure 2-9.
2. Set the Frequency/Time Interval Counter to "Totalize", to count the number of pulses each time it is triggered.
3. Reset the channel one pulse generator module to the defaults, change the following parameters, then press Execute:

Confg: Internal Trig
Frequency: 10 MHz
Function: Single pulse
Width: 50 ns
Mode: Burst
Burst Count: (see steps 4, 6, and 8)
Upper Level: +5V
Lower Level: -5V
Output: On

4. Set the channel one pulse generator module to a burst count of 3.
5. Press the front panel "Manual Trigger" key to provide a trigger for the burst function. Verify that there is a burst output of 3 on the Frequency/Time Interval Counter.
6. Set the channel one pulse generator module to a burst count of 15.
7. Press the Front Panel System "Manual Trigger" key to provide a trigger for the burst function. Verify that there is a burst output of 15 on the Frequency/Time Interval Counter.
8. Set the channel one pulse generator module to a burst count of 349,520.
9. Press the Front Panel System "Manual Trigger" key to provide a trigger for the burst function. Verify that there is a burst output of 349,520 on the Frequency/Time Interval Counter.

2.12.4 Pulse Level/Amplitude Accuracy Test

This test is used to verify that the single pulse upper level and amplitude is accurate on the X1 range.

Measurement Method

Many modern digitizing oscilloscopes can be used to measure the pulse amplitude and levels. They can be used to evaluate pulses beyond 100 MHz with 1% or 2% accuracy. However, the terminator and attenuator used at the input of the digitizer can be a major source of error. For precision measurements, the exact characteristics of the digitizer system must be evaluated by applying a precision reference pulse signal or dc voltage to the system before it can be used for measurements.

A more accurate measurement method is to measure the pulse levels with a DVM. The lower level is measured while the pulse generator is set to the trigger mode. The upper level can be measured by switching the pulse polarity from normal to complementary. The result of this method agrees closely with the measured upper and lower levels of low frequency, wide pulse width pulses.

For the convenience of most users, the following procedure is based on the second method above, using DVM for the measurement. If there is any terminator or attenuator to be used in the test system, it must be precise to 0.1%, or its impedance and attenuation ratio must be known to within 0.1% and the result is taking into account.

1. Interconnect the required test equipment as shown in figure 2-11.

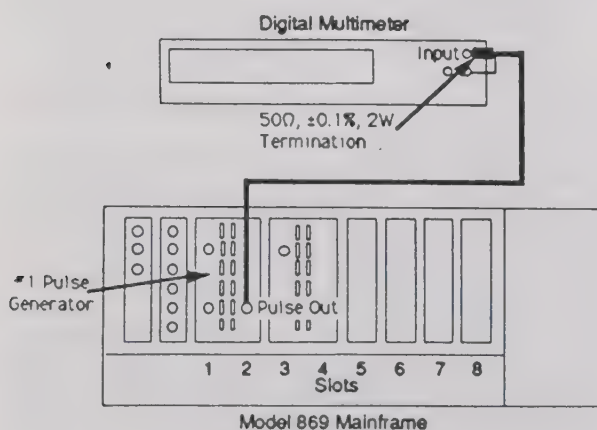


Figure 2-11. Pulse Accuracy Test Hookup

2. Set the DMM to the following parameters:

Function: Vdc
Range: Auto

3. Reset the channel one pulse generator module to the defaults, change the following parameters, then press Execute:

Function: Single Pulse
Mode: Trigger
Upper Level: +10V
Lower Level: 0.0V
Polarity: Normal
Output: On
Attenuator: Enabled

4. Record the Lower Level reading shown on the DMM and verify that it is within the values listed in table 2-10.
5. Change the following parameter on the channel one pulse generator and then press Execute:

Polarity: Complement

6. Record the Upper Level reading shown on the DMM and verify that it is within the values listed in table 2-10.
7. Calculate the Amplitude by subtracting the Lower Level reading from the Upper Level reading. Record the Amplitude value in table 2-10.
8. Use a similar method and continue to take upper and lower level voltage readings in each of the following settings:

Upper Level	Lower Level	Amplitude (calculate)
10.0	0	10.00 approx.
4.5	-3.0	7.50 approx.
0.1	-5.0	5.10 approx.

2.12.5 Attenuator Accuracy Tests

This test is used to verify the accuracy of the X2 and X4 attenuators.

1. Perform steps 1 and 2 of the Pulse Level/Amplitude Accuracy Test.
2. Reset the channel one pulse generator module to the defaults, change the following parameters, then press Execute:

Mode: Trigger
Upper Level: +5.0V
Lower Level: 0.0V
Polarity: Normal
Output: On

- Record the Lower Level reading shown on the DMM and verify that it is within the values listed in table 2-10.
- Change the following parameter on the channel one pulse generator and then press Execute:

Polarity: Complement

- Record the Upper Level reading shown on the DMM and verify that it is within the values listed in table 2-10.
- Calculate the Amplitude by subtracting the Lower Level reading from the Upper Level reading. Record the Amplitude value in table 2-10.
- Use the same steps to take upper and lower level voltage readings for the following setting:

Upper Level	Lower Level	Amplitude (calculate)
2.5V	0.0V	2.50V approx.

2.12.6 Delay Accuracy Test

This test is used to verify that the delay accuracy of the single pulse, double pulse, and square waveforms, in reference to the Sync Out waveform, is within limits.

- Interconnect the required test equipment as shown in figure 2-12. Verify that cables and oscilloscope channel delay skewing are matched within ± 250 ps.

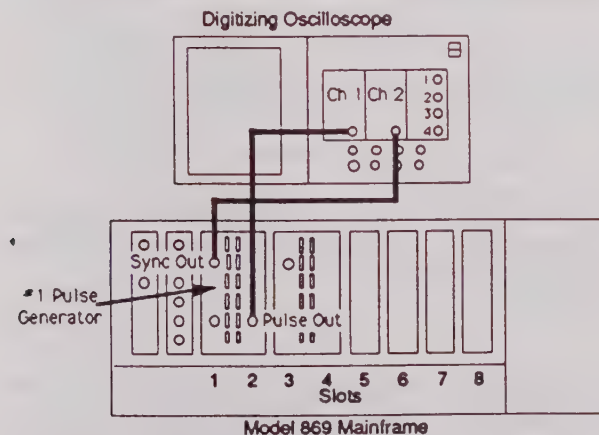


Figure 2-12. Delay and Width Accuracy Hookup

- Set the Digitizing Oscilloscope to measure the following parameter:

Delay Time

- Reset the channel one pulse generator module to the defaults, change the following parameters, and then press Execute:

Function: Single Pulse
 Frequency: 10 MHz
 Width: 10 ns
 Lead Transition: 1 ns
 Trail Transition: 1 ns
 Delay: 0.0 ns
 Upper Level: +5V
 Lower Level: -5V
 Output: On

NOTE

Refer to paragraph 2.11.3 for pulse measuring definitions. For correct delay measurements, the pulse leading edge (10% to 90%) transition time should be measured. Therefore: Delay (time) = Delay (measured) - 0.625 • Leading Edge.

- Measure the delay time shown on the oscilloscope and record the value in table 2-10. Verify that it is within the values listed.
- Using the same procedures as before continue to take delay measurements for the following settings.

Func	Period	Width	Lead	Trail	Delay (set & read)
Single	1.00 ns	10 ns	1 ns	1 ns	20 ns
Double	1.00 ns	10 ns	1 ns	1 ns	20 ns
Single	1 μ s	100 ns	1 ns	1 ns	89.0 ns
Compl Pulse	1 μ s	—	1 ns	1 ns	89.0 ns
Single	750 ms	50 ms	10 μ s	20 μ s	557.8 ms
Compl Pulse	750 ms	50 ms	10 μ s	20 μ s	557.8 ms

2.12.7 Width Accuracy Test

This test is used to verify that the width accuracy of the single and double pulse waveforms, is within limits.

- Interconnect the required test equipment as shown in figure 2-12.
- Set the Digitizing Oscilloscope to measure Pulse Width.
- Reset the channel one pulse generator module to the defaults, change the following parameters, then press Execute:

Function: Single Pulse
 Frequency: 10 MHz
 Width: 10 ns
 Lead Transition: 1 ns
 Trail Transition: 1 ns
 Delay: 0 ns
 Upper Level: +5V
 Lower Level: -5V
 Output: On
 Attenuator: Enabled

NOTE

Refer to paragraph 2.11.3 for pulse measuring definitions.

- Measure the pulse width shown on the oscilloscope and record the value in table 2-10. Verify that it is within the values listed.
- Use similar procedures as above and continue to take width measurement for the following settings.

Func	Period	Width	Lead	Trail	Delay (set & read)
Single	100 ns	30 ns	1 ns	1 ns	35 ns
Compl Pulse	100 ns	30 ns	1 ns	1 ns	35 ns
Single	1 μ s	30 ns	1 ns	1 ns	145.2 ns
Single	750 ms	50 ms	10 μ s	20 μ s	298.5 ms

2.12.8 Transition Time/Waveform Quality Test

This test is used to verify the squarewave transition time, overshoot and/or peak-to-peak value of the pulse top ringing.

- Interconnect the required test equipment as shown in figure 2-12.
- Reset the channel one pulse generator module to the defaults, change the following parameters, then press Execute:

Frequency: 10 MHz
 Upper Level: +5V
 Lower Level: -5V
 Lead Transition: 1.0 ns
 Trail Transition: 1.0 ns
 Output: On

NOTE

Refer to paragraph 2.11.3 for pulse measuring definitions.

- Measure the upper and lower waveform aberrations of the squarewave shown on the oscilloscope (refer to figure 2-8) and record the value in table 2-10. Verify that it is within the values listed.
- Measure the leading and trailing edge transition times shown on the oscilloscope and record the values in table 2-10. Verify that they are within the values listed.
- Reset the channel one pulse generator to the following parameters and use the same procedure shown above to measure the aberration and transition times:

Period	Upper L	Lower L	Leading	Trailing
10.0 μ s	+1.1 V	-1.1 V	260 ns	4.3 μ s
100 ns	+2.51 V	-2.51 V	1.0 ns	1.0 ns
500 ns	+5.0 V	-5.0 V	350 ns	25 ns
10.0 μ s	+5.0 V	-5.0 V	1.43 μ s	2.48 μ s
10.0 μ s	+2.51 V	-2.51 V	258 ns	1.88 μ s
10.0 μ s	+1.1 V	-1.1 V	260 ns	4.3 μ s

2.12.9 Sync Out Waveform Quality Test

This test is used to verify that the Sync Out waveform voltages, leading and trailing transition times, and symmetry are within limits.

- Interconnect the required test equipment as shown in figure 2-13.

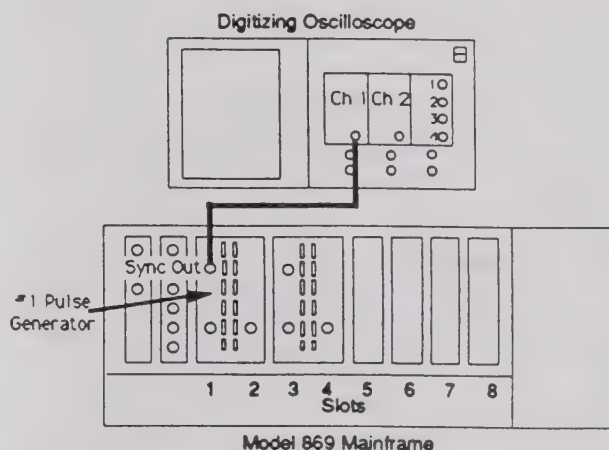


Figure 2-13. Sync Out Waveform Hookup

- Reset the channel one pulse generator module to the defaults, change the following parameters, then press Execute:

Output: On

- Measure the waveform upper and lower level voltages shown on the oscilloscope and record the values in table 2-10. Verify that they are within the values listed.
- Reset the channel one pulse generator to the following parameter and press Execute:

Frequency: 10 MHz

- Measure the waveform transition times shown on the oscilloscope and record the values in table 2-10. Verify that they are within the values listed.

6. Measure the waveform duty cycle shown on the oscilloscope and record the value in table 2-10. Verify that it is within the values listed.

NOTE

$$\text{Duty Cycle (\%)} = (\text{Pos Pulse width} / \text{Pulse period}) \times 100$$

2.12.10 Programmable Trigger Level/Slope Test

This test is used to perform a functional test of the trigger slope control and verify the operation of the programmable trigger level.

Definition of Trigger Level: The Trigger Level Detector circuit switches at a slightly different voltage level between the two slopes of the input signal. This voltage difference is called the trigger hysteresis. The trigger level is defined as the average voltage between the two levels of the hysteresis.

Test Methods: There are two methods can be used to test the trigger level operation. Perform only one of the following tests as necessary. The first method is a trigger level accuracy test. The second method is a functional test, not a level precision test. For most practical purposes, the second method is a simple and adequate test to ensure Trigger circuit proper operation.

Test Method No.1, Level accuracy and slope tests:

1. Interconnect the required test equipment as shown in figure 2-14. The DC Source can be any voltage source or generator which can supply from 0V up to $\pm 10V$ into 50Ω .

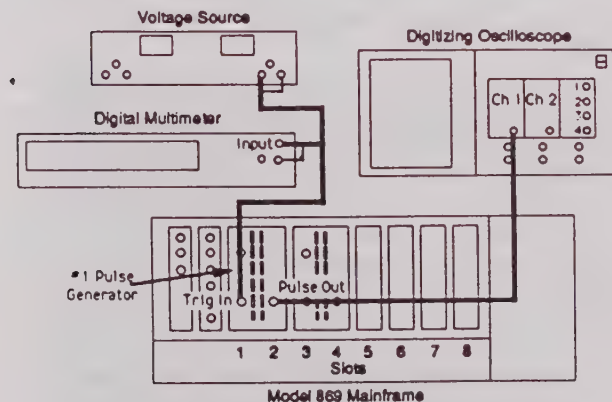


Figure 2-14. Trigger Level/Slope Hookup #1

2. Set the DMM to read the voltage at the Pulse Generator Trig In connector.

3. Set the DC Source to $-1V \pm 10$ mV.
4. Reset the channel one pulse generator module to the defaults, change the following parameters, then press Execute:

Function:	Single Pulse
Width:	100 μs
Mode:	Sgate
Trigger Input:	External
Trigger Slope:	Positive
Trigger Level:	0V
Output:	On

5. With the DC Source voltage set to -1 volt the output of the pulse generator is a 0 Vdc level.
6. Slowly increase the voltage until a stable 1 kHz pulse is seen at the Pulse Out connector. Measure the voltage shown on the DMM and record the value as the "trig on" level.
7. Then slowly decrease the DC Source voltage until the Pulse Out waveform disappears. Measure the voltage shown on the DMM and record the value as the "trig off" level.
8. Using the formula below, determine the trigger level and record in table 2-10. Verify that it is within the values listed.

$$\text{Trig Level} = (\text{trig on level} + \text{trig off level}) / 2$$

9. Change the Trigger Slope of the channel one pulse generator to "negative."
10. Start the DC Source voltage at $+1$ volts. The output of the pulse generator is a 0V dc level.
11. Slowly decrease the voltage until the a 1 kHz pulse is seen at the Pulse Out connector. Measure the voltage shown on the DMM and record the value as "trig on" level.
12. Then slowly increase the DC Source voltage until the Pulse Out connector waveform disappears. Measure the voltage shown on the DMM and record the value as "trig off" level.
13. Using the formula below, determine the trigger level and record in table 2-10. Verify that it is within the values listed.

$$\text{Trig Level} = (\text{trig on level} + \text{trig off level}) / 2$$

14. Repeat steps 5 to 13, but use a Trigger Level of $+10V$. Start the DC Source 1 volt below or above the programmed level for the testing.
15. Repeat steps 5 to 13, but use a Trigger Level of $-10V$. Start the DC Source 1 volt below or above the programmed level for the testing.

Test Method No.2, function test:

- Interconnect the required test equipment as shown in figure 2-15.

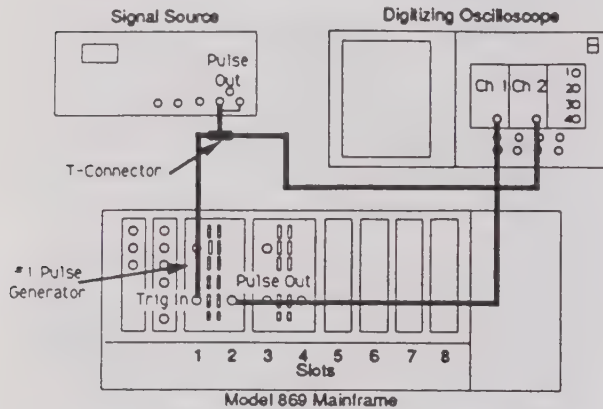


Figure 2-15. Trigger Level/Slope Hookup #2

- Set the signal source at the input of the Trig In connector to the following parameters:

Function: Squarewave
 Frequency: 1 kHz
 Upper Level: +500 mV
 Lower Level: -500 mV

- Reset the channel one pulse generator module to the defaults, change the following parameters, then press Execute:

Function: Single Pulse
 Frequency: 10 kHz
 Width: 10 μ s
 Mode: Agate
 Trigger Input: External
 Trigger Slope: Positive
 Trigger Level: 0V
 Output: On

- Observe a Burst of pulses output from the Pulse Out connector while the signal at Trig In is "high" and no pulses while the Trig In is "low".
- Change the Trigger Slope of the channel one pulse generator to "negative."
- Observe a Burst of pulses output from the Pulse Out connector while the signal at Trig In is "low" and no pulses while the Trig In is "high".
- Set the signal source applied to the Trig In connector to the following parameters:

Upper Level: +10V
 Lower Level: +9.0V

- Set the channel one pulse generator to the following parameters and press Execute:

Trigger Level: +9.5V
 Trigger Slope: Positive

- Observe a Burst of pulses output from the Pulse Out connector while the signal at Trig In is "high" and no pulses while the Trig In is "low".
- Change the Trigger Slope of the channel one pulse generator to "negative."
- Observe a Burst of pulses output from the Pulse Out connector while the signal at Trig In is "low" and no pulses while the Trig In is "high".
- Set the signal at the Trig In connector to the following parameters:

Upper Level: -10V
 Lower Level: -9.0V

- Set the channel one pulse generator to the following parameters and press Execute:

Trigger Level: -9.5V
 Trigger Slope: Positive

- Observe a Burst of pulses output from the the Pulse Out connector while the signal at Trig In connector is "high" and no pulses while the Trig In is "low".
- Change the Trigger Slope of the channel one pulse generator to "negative."
- Observe a Burst of pulses output from the Pulse Out connector while the signal at Trig In is "low" and no pulses while the Trig In is "high".

2.12.11 Master/Slave Mode Examples and Test.

The main purpose of the Master and Slave mode of operation is to provide synchronization of frequency and timing when using two or more modules contained within the same chassis. By using the System Sync input/output connectors and buffer amplifiers, an almost unlimited number of mainframes can be synchronized together for multi-channel applications.

NOTE

The Master/Slave mode of operation works in conjunction with the System Sync Bus (SSYNC) which is a bus on the motherboard of the mainframe. It connects all eight slots in parallel. This allows any module installed in the same mainframe to send clock signal to or to receive clock signals from any other module via the motherboard SSYNC Bus.

Example for systems with Model 869 Mainframe:

Mainframe and module requirements:

- 1 Model 869 System Mainframe
- 1 Model 680-03 Pulse Generator, installed in slots 1 & 2.
- 1 Model 680-03 Pulse Generator, installed in slots 3 & 4.

- Interconnect the required test equipment as shown in figure 2-16.

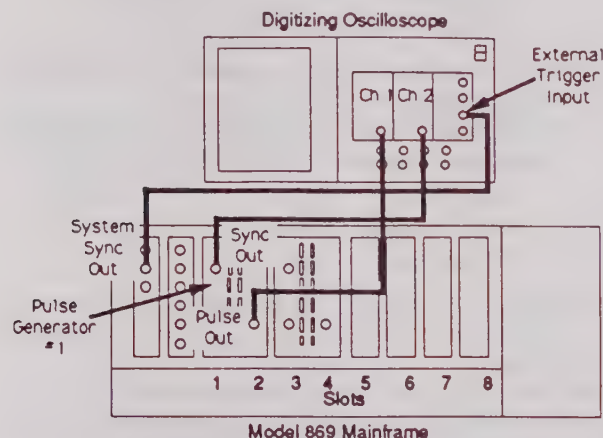


Figure 2-16. Master/Slave Mode Hookup #1

- Reset the entire Model 869 system by,

Channel Select:	All	Select all channels
Reset:	Soft	Reset all channels
Output:	On	Close all output relays

NOTE

- At power on or after a system reset, the first module found in the mainframe is set to be the Master channel, and all other Pulse Generator modules are set to be slave. The frequency for all of the channels are determined by the setting of the master channel, Ch. 1 in this example.
- Set the oscilloscope to trigger on its Ch.3 or Ext Trig Input, the System Sync Output, and verify that all of the Model 869 channel outputs are 1 kHz square waves.
 - Change the channel 1 module settings to the following parameters, the press Execute:

Channel Select:	#1
Frequency:	10 MHz
Function:	Single Pulse
Pulse Delay:	20 ns

- Verify that the frequency on all channels is changed to 10 MHz. The output of channel 1 changes to a pulse output with 5 ns pulse width and pulse delay of approximately 20 ns relative to the channel 1 Sync Out signal.
- Remove the coax from the channel 1 Sync Out connector and reconnect to the channel 2 Pulse Out connector as shown in figure 2-17.

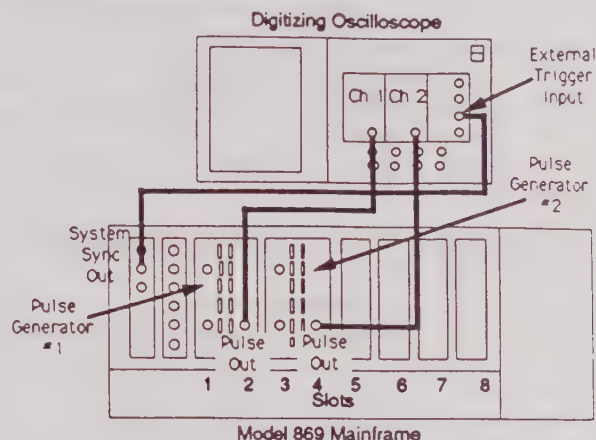


Figure 2-17. Master/Slave Mode Hookup #2

- Change the channel 2 module settings to the following parameters, the press Execute:

Channel Select:	#2
Frequency:	20 MHz
Function:	Single Pulse
Pulse Delay:	30 ns
Pulse Width:	20 ns

- Verify that the output signal from channel 2 as seen on the oscilloscope agrees with the new settings except that the frequency remains at 10 MHz because channel 2 is defined as a slave channel and its output frequency follows the Master channel.
- Change the channel 2 module Sync Mode to independent. Set the oscilloscope to trigger on channel 2 input and verify that the output frequency of channel 2 is 20 MHz, twice that of channel 1.
- Change the Sync Mode of channel 2 to Master and the Sync Mode of channel 1 to Slave. Verify that channel 1 is clocked at 20 MHz.
- If the System Sync Output is connected to the System Sync Input of another Model 869 Mainframe, an additional four channels can be slaved with the original four channels to form an eight channel pulse Generator. Additional mainframes can be slaved together in a similar manner.

2.12.12 System Trigger Input/Out Test

This test requires two Model 680-03 Pulse Generators to be installed in a Model 869 Mainframe. The first pulse generator module, channel 1, is used to trigger the second pulse generator module, channel 2, through the use of the external input or the internal trigger bus, STRIG Bus. Signals from various internal circuits of the first pulse generator will be output to the STRIG Bus and used to trigger the second pulse generator module.

Mainframe and module requirements:

- 1 Model 869 System Mainframe.
 - 1 Model 680-03 Pulse Generator, channel 1, installed in slots 1 & 2.
 - 1 Model 680-03 Pulse Generator, channel 2, installed in slots 3 & 4.
1. Interconnect the required test equipment as shown in figure 2-18.

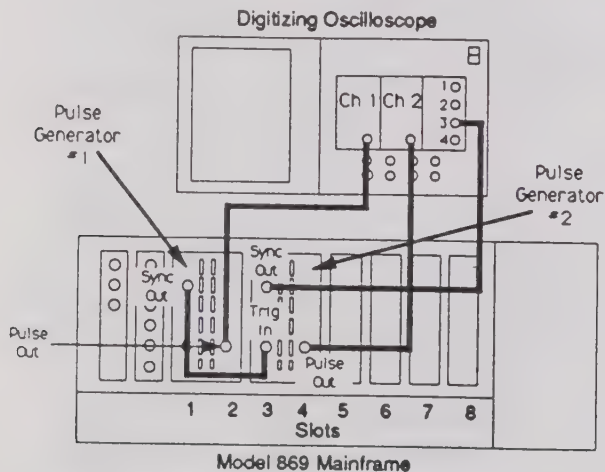


Figure 2-18. System Trigger Input/Output Hookup

2. Reset the Model 869 System Mainframe.

NOTE

Set the oscilloscope to trigger on Ch.3, the Sync Output.

3. Reset the channel 1 pulse generator module by pressing the Channel Select key and number 1 on the numeric keypad, followed by the Reset key. Change the following parameters, and then press Execute:

Function:	Single Pulse
Frequency:	10 kHz
Pulse Delay:	20 μ s
Pulse Width:	30 μ s
Output:	On
Sync Mode:	Indep

4. Reset the channel 2 pulse generator module by pressing the Channel Select key and number 2 on the numeric keypad, followed by the Reset key. Change the following parameters, and then press Execute:

Function:	Single Pulse
Frequency:	100 kHz
Pulse Delay:	1 μ s
Pulse Width:	5 μ s
Trig Level:	0.5V
Sync Mode:	Indep
Output:	On

5. Verify that both channels are running independently of each other at 10 kHz and 100 kHz.
6. Change the following parameters for the channel 2 pulse generator module, then press Execute:

Sync Mode:	Sgate
Trigger Input:	External
Trigger Level:	0.8V

7. Verify that channel 2 is gated on and off by the Sync signal from channel 1 through the Trigger Input connector.
8. Disconnect the cable between the Sync Out of channel 1 and the Trig In of channel 2. Change the following parameters for the channel 1 pulse generator module, and then press Execute:

Trigger Output: Delay

9. Change the following parameters for the channel 2 pulse generator module, and then press Execute:

Trigger Input:	Internal
Mode:	Ext Width

10. Verify that the channel 2 pulse generator module is gated on and off by channel 1. The pulse "on time" is approximately equal to the channel 1 delay time.
11. Change the following parameters for the channel 1 pulse generator module, then press Execute:

Trigger Output: Width

12. Verify that the channel 2 pulse generator module is gated on and off by channel 1. The pulse "on time" is equal to the channel 1 pulse width and with near-zero delay with respect to Channel 1.
13. Change the following parameters for the channel 1 pulse generator module, then press Execute:

Trigger Output: Sync

14. Verify that the channel 2 pulse generator module is gated on and off by channel 1. The pulse "on time" will be approximately equal to 50% of the period of channel 1.

Table 2-10. Module Performance Verification Test Report

Frequency Accuracy Test (para 2.12.1)

Step 5.

Freq Setting	Tol	Measured Value	Lo limit	HI Limit
200.0000 MHz	5 ppm	_____	199.999	200.001
49.0000 MHz	5 ppm	_____	48.999755	49.000245
12.0000 MHz	5 ppm	_____	11.999940	12.000060
4.9256 MHz	5 ppm	_____	4.925575	4.925625
1.2499 MHz	5 ppm	_____	1.249894	1.249906

Operating Mode Test (para 2.12.2)

Continuous Mode

Step 4.

Pulse Out Signal	Tol	Verified?	
Function: Squarewave		Yes	No
Frequency: 1 kHz	±50 Hz	Yes	No
Upper Limit: +0.5V	±0.05V	Yes	No
Lower Limit: -0.5V	±0.05V	Yes	No

Sync Out Signal	Tol	Verified?	
Function: Squarewave		Yes	No
Frequency: 1 kHz	±50 Hz	Yes	No
Upper Limit: > +1.0V		Yes	No
Lower Limit: < 0.2V		Yes	No

Triggered (low freq) Mode

Step 5.

Pulse Out Signal	Tol	Verified?	
Function: Single Pulse		Yes	No
Frequency: 2 kHz	±100 Hz	Yes	No
Pulse Width: 1 µsec	±0.1 ns	Yes	No
Upper Limit: +0.5V	±0.05V	Yes	No
Lower Limit: -0.5V	±0.05V	Yes	No

Triggered (high freq) Mode

Step 4.

Pulse Out Signal	Tol	Verified?	
Function: Single Pulse		Yes	No
Frequency: 50 MHz	± 5 MHz	Yes	No
Pulse Width: 10 nsec	± 2 ns	Yes	No
Upper Limit: +0.5V	± 0.05 V	Yes	No
Lower Limit: -0.5V	± 0.05 V	Yes	No

Burst Mode

Step 4.

Pulse Out Signal	Tol	Verified?	
Function: Burst (1)		Yes	No
Frequency: 10 MHz (2)	± 0.5 MHz	Yes	No
Burst Count: 2 (3)	± 0 cnt	Yes	No
Pulse Width: 40 nsec	± 4 ns	Yes	No
Upper Limit: +0.5V	± 0.05 V	Yes	No
Lower Limit: -0.5V	± 0.05 V	Yes	No

Note 1: 2 cycles of a single pulse for every input trigger.

Note 2: Burst of 2 and more.

Note 3: Repeat for a burst of 3, 4, etc.

Sync Select Mode

Sync Out Signal	Tol	Verified?	
Step 2: Burst of 4 pulses		Yes	No
Step 4: No Output		Yes	No
Step 5: High Level (4)		Yes	No

Note 4: Remains high when Pulse Out is generating pulses. Low if pulses stop.

Sync Gated Mode

Step 4.

Pulse Out Signal	Tol	Verified?	
Function: Single pulse		Yes	No
Frequency: 1 MHz burst	± 100 kHz	Yes	No
Burst Count: (5)		Yes	No
Pulse Width: 400 nsec	± 40 ns	Yes	No
Upper Limit: +0.5V	± 0.05 V	Yes	No
Lower Limit: -0.5V	± 0.05 V	Yes	No

Note 5: Will vary from 3 to more cycles, always a complete cycle.

Async Gated Mode

Step 2.

Pulse Out Signal	Tol	Verified?	
Function: Single pulse		Yes	No
Frequency: 1 MHz burst	± 100 kHz	Yes	No
Burst Count: (6)		Yes	No
Pulse Width: 400 nsec	± 40 ns	Yes	No
Upper Limit: +0.5V	± 0.05 V	Yes	No
Lower Limit: -0.5V	± 0.05 V	Yes	No

Note 6: Will vary from 3 to more cycles, the last cycle will not always be a complete cycle.

External Width Mode

Step 2.

Pulse Out Signal	Tol	Verified?	
Function: Single pulse		Yes	No
Frequency: 50 kHz	± 5 kHz	Yes	No
Pulse Width: (7)		Yes	No
Upper Limit: +0.5V	± 0.05 V	Yes	No
Lower Limit: -0.5V	± 0.05 V	Yes	No

Note 7: Will vary from 3.5 to 7 μ sec depending on the pulse width of the input trigger waveform.

Burst Count Test

Pulse Out Signal	Tol	Verified?	
Step 5: Burst Count: 3	± 0 cnt	Yes	No
Step 7: Burst Count: 15	± 0 cnt	Yes	No
Step 9: Burst Count: 349,520	± 0 cnt	Yes	No

Pulse Level/Amplitude Accuracy Test (para 2.12.4)

Pulse Out Signal	Tol	Measured Value	Lo limit	HI Limit
Step 4: Lower level 0.0V		_____		
Step 5: Upper level +10.0V	± 200 mV	_____	9.80V	10.20V
Step 6: Amplitude (8)	$\pm 2\%, \pm 50$ mV	_____	9.75 Vpp	10.25 Vpp
Step 8: Lower level -3.0V		_____		
Step 8: Upper level +4.5V	± 200 mV	_____	4.30V	4.70V
Step 8: Amplitude (8)	$\pm 2\%, \pm 50$ mV	_____	7.30 Vpp	7.70 Vpp
Step 8: Lower level -5.0V		_____		
Step 8: Upper level +0.1V	± 200 mV	_____	-0.0V	+0.30V
Step 8: Amplitude (8)	$\pm 2\%, \pm 50$ mV	_____	4.948 Vpp	5.252 Vpp

Note 8: Calculate the amplitude by subtracting the measured lower level reading from the measured upper level reading.

Attenuator Accuracy Test (para 2.12.5)

Pulse Out Signal	Tol	Measured Value	Lo limit	HI Limit
Step 8: Lower level 0.0V		_____		
Step 8: Upper level +5.0V	$\pm 120 \text{ mV}$	_____	4.88V	5.12V
Step 8: Amplitude (8)	$\pm 4\%, \pm 25 \text{ mV}$	_____	4.775 Vpp	5.225 Vpp
Step 8: Lower level 0.0V		_____		
Step 8: Upper level +2.5V	$\pm 60 \text{ mV}$	_____	2.44V	2.56V
Step 8: Amplitude (8)	$\pm 4\%, \pm 13 \text{ mV}$	_____	2.387 Vpp	2.613 Vpp

Delay Accuracy Test (para 2.12.6)

Pulse Out Signal	Tol	Measured Value	Lo limit	HI Limit
Step 4: Delay 0.0 ns	$\pm 5 \text{ ns}$	_____	-5.0 ns	+5.0 ns
Step 5-1: Delay 20.0 ns	$\pm (1\% \pm 5 \text{ ns})$	_____	14.80 ns	25.20 ns
Step 5-2: Delay 20.0 ns	$\pm (1\% \pm 5 \text{ ns})$	_____	14.80 ns	25.20 ns
Step 5-3: Delay 89 ns	$\pm (1\% \pm 5 \text{ ns})$	_____	83.11 ns	94.89 ns
Step 5-4: Delay 89 ns	$\pm (1\% \pm 5 \text{ ns})$	_____	83.11 ns	94.89 ns
Step 5-5: Delay 557.766 ms	$\pm (1\% + D) (9)$	_____	554.419 ms	561.112 ms
Step 5-6: Delay 557.766 ms	$\pm (1\% + D) (9)$	_____	554.419 ms	561.112 ms

Note 9: $D = 0.015 \times \text{Leading Transition Time (typical)}$. Delay accuracy is affected by the leading edge transition time accuracy.

Width Accuracy Test (para 2.12.7)

Pulse Out Signal	Tol	Measured Value	Lo limit	HI Limit
Step 4: Width 10 ns	$\pm (1\% \pm 2 \text{ ns})$	_____	7.90 ns	12.10 ns
Step 5-1: Width 35 ns	$\pm (1\% \pm 2 \text{ ns})$	_____	32.65 ns	37.35 ns
Step 5-2: Width 35 ns	$\pm (1\% \pm 2 \text{ ns})$	_____	32.65 ns	37.35 ns
Step 5-3: Width 145.2 ns	$\pm (1\% \pm 5 \text{ ns})$	_____	138.75 ns	151.65 ns
Step 5-4: Width 298.45 ns	$\pm (1\% + W) (10)$	_____	295.465 ms	301.435 ms

Note 10: $W = 0.030 \times (\text{Leading Transition} + \text{Trailing Transition})$. Pulse width accuracy is affected by both the leading edge and trailing edge transition time accuracy.

Transition Time/Quality Test (para 2.12.8)

Pulse Out Signal	Tol	Measured Value	Lo limit	HI Limit
Step 3: Aberration #1	$< 5\%$	_____	0.0	500 mV
Step 3: Aberration #2	$< 5\%$	_____	0.0	500 mV
Step 4: Lead trans 1.0 ns	$< 2 \text{ ns}$	_____	—	2 ns
Step 4: Trail trans 1.0 ns	$< 2 \text{ ns}$	_____	—	2 ns
Step 5-1: Aberration #1	$< 350 \text{ mV}$	_____	0.0	350 mV
Step 5-1: Aberration #2	$< 350 \text{ mV}$	_____	0.0	350 mV
Step 5-1: Lead trans 1.0 ns	$< 2 \text{ ns}$	_____	—	2 ns
Step 5-1: Trail trans 1.0 ns	$< 2 \text{ ns}$	_____	—	2 ns

Step 5-2: Aberration #1	<5%	_____	0.0	500 mV
Step 5-2: Aberration #2	<5%	_____	0.0	500 mV
Step 5-2: Lead trans 350 ns	$\pm(10\%+2\text{ ns})$	_____	313 ns	387 ns
Step 5-2: Trail trans 25 ns	$\pm(5\%+2\text{ ns})$	_____	21.75 ns	28.25 ns
Step 5-3: Aberration #1	<5%	_____	0.0	500 mV
Step 5-3: Aberration #2	<5%	_____	0.0	500 mV
Step 5-3: Lead trans 1.43 μ s	$\pm 5\%$	_____	1.36 μ s	1.5 μ s
Step 5-3: Trail trans 2.48 μ s	$\pm 5\%$	_____	2.354 μ s	2.606 μ s
Step 5-4: Aberration #1	<350 mV	_____	0.0	350 mV
Step 5-4: Aberration #2	<350 mV	_____	0.0	350 mV
Step 5-4: Lead trans 258 ns	$\pm(5\%+2\text{ ns})$	_____	243.1 ns	272.8 ns
Step 5-4: Trail trans 188 μ s	$\pm 5\%$	_____	1.784 μ s	1.976 μ s
Step 5-5: Aberration #1	<110 mV	_____	0.0	110 mV
Step 5-5: Aberration #2	<110 mV	_____	0.0	110 mV
Step 5-5: Lead trans 260 ns	$\pm(5\%+2\text{ ns})$	_____	245 ns	275 ns
Step 5-5: Trail trans 4.30 μ s	$\pm 10\%$	_____	3.868 μ s	4.732 μ s

Sync Out Waveform Quality Test (para 2.12.9)

Sync Out Signal	Tol	Measured Value	Lo limit	HI Limit
Step 3: Upper Level		_____	1.0V	1.6V
Step 3: Lower Level		_____	-0.02V	0.2V
Step 5: Leading trans time		_____	1 ns	5 ns
Step 5: Trailing trans time		_____	1 ns	5 ns
Step 6: Duty Cycle (11)		_____	45%	55%

Note 11: Calculate the Duty Cycle using the following formula:
Duty Cycle (%) = (Pos Pulse Width / Pulse Period) x 100.

Programmable Trigger Level/Slope Test (para 2.12.10)

Test Method #1

Trig In Signal	Tol	Measured Value	Lo limit	HI Limit
Step 6: Trig On level		_____		
Step 7: Trig Off level		_____		

Master/Slave Mode Test (para 2.12.11)

Signal Conditions	Verified?
Step 3: All Channels are 1 kHz squarewave	Yes No
Step 5: All Channels are 10 MHz squarewave	Yes No
Step 8: Frequency stays at 10 MHz	Yes No
Step 9: Channel 2 frequency changes to 20 MHz	Yes No
Step 10: Channel 1 frequency changes to 20 MHz	Yes No

System Trigger Input/Output Test (para 2.12.12)

Signal Conditions

Verified?

Step 5: Channels are running independently	Yes	No
Step 7: Channel 2 gated by Chan 1 Sync Output	Yes	No
Step 10: Channel 2 gated by Chan 1 delay signal	Yes	No
Step 12: Channel 2 gated by Chan 1 width signal	Yes	No
Step 14: Channel 2 gated by Chan 1 Sync signal	Yes	No

3

SECTION

OPERATION

3.1 INTRODUCTION

The front panel controls allow local operation. It should not be necessary to change any of the rear panel switch settings once the unit has been installed as in paragraph 2.6 of this manual; use the front panel controls to manually operate the Model 869 after installation.

The Model 680-03 100 MHz Pulse Generator module used in the Model 869 can be operated in either a Model 680 Mainframe or an Model 869 Mainframe. This manual will discuss operation only in a Model 869 Mainframe. For operation in an Model 680 Mainframe, refer to the Model 680 Mainframe Operator Manual. In both mainframes, the Pulse Generator module can be controlled either locally with the front panel controls (paragraph 3.2) or remotely by an instrumentation controller (paragraph 3.25).

3.2 FRONT PANEL DISPLAY, CONTROLS, AND KEYS

The following section describes in detail the front panel function keys. To see how all of these keys can be used to create a waveform, refer to the performance verification procedure described in paragraph 2.7 and 2.11.

The front panel keys selects and controls both the Model 869 System Mainframe and channel functions. Table 3-1 briefly describes each key function and lists the paragraphs which contain detailed information.

The keys located in the outlined block of the front panel called "Pulse Parameters" are used only with the installed channels and not with the mainframe. The front panel outlined block keys called "Operations" pertain for the most part to the operation of both the Mainframe and the channels but have certain restrictions in the use of some keys. All other keys are global keys.

Table 3-1. Model 869 Key General Descriptions

Menu Key	General Description	Detailed Desc
Execute	When entering a parameter value or setting with the numeric keypad, system status is not changed until the EXECUTE key is pressed. Execute is automatic when the Cursor keys or the Control knob is used.	Para 3.6
Channel	Calls a menu that shows the location of all of the installed channels. Pressing a numeric key that corresponds to the mainframe or a listed channel generates the top level menu for the mainframe or that channel on the display.	Para 3.8
Reset	Sets the mainframe, the selected channel, or both to the default conditions used at power up.	Para 3.9
Cal/Test	Allows the automatic calibration (AutoCal), Self-test, or Quick Calibration of the selected channel(s) or Self-test of the mainframe.	Para 3.10
Manual Trigger (No Menu display)	The Manual Trigger key asserts or gates the 869 System from the front panel. This key will cause a manual trigger only on the currently selected channel. Select the desired channel with the Channel Select key.	Para 3.13
Status	Displays the current parameters for the selected channel. If "all" is selected, it displays the installed channels. This function is not operative when the mainframe is selected.	Para 3.11

Store/Recall	The System Stored Settings menu stores/recalls instrument setups making it unnecessary to manually reprogram the most frequently used setups of System and function channel settings.	Para 3.12
Output	The Output menu allows the user to turn the rear panel outputs "on" or "off" from the front panel. The default setting is the "off" condition. The polarity of the pulse output can also be controlled using this menu.	Para 3.14
Trig/Sync	Controls the System Trigger (STRIG) function and allows the user to select either internal or external triggers and also the characteristics of the trigger such as frequency, level, polarity, number of external triggers required for a valid System Trigger (STRIG), and trigger slope, threshold and delay. Controls clock or gate selections for the Sync Mode of operation. Controls the selection of master, slave, or independent operation when using the Sync Mode.	Para 3.19
Levels	Allows the user to set the instrument to the desired output voltage levels and attenuation control.	Para 3.15
Mode	Allows the user to set the instrument to the desired mode of operation such as triggered, burst, or continuous, etc.	Para 3.18
Timing	Allows the user to set the instrument to the desired period or frequency of operation. Additional selections include setting the leading and trailing transition time of pulse waveforms and also setting the pulse width and the pulse delay times.	Para 3.16
Function	Allows the user to set the instrument to the desired output waveform.	Para 3.17

3.3 FRONT PANEL DISPLAY

The Model 869 uses a four line, 40 character width, backlighted liquid crystal display. The display format consists of six fields; each field is allocated for a specific information type. Figure 3-1 shows the field allocations and each field is described in the paragraphs that follow.

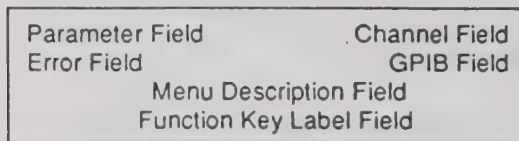


Figure 3-1. Display Fields

Parameter Field — The parameter field in line one consists of the first 36 characters. This field will indicate the parameter being displayed in lower case letters followed by a colon and one space and then the value of the parameter.

Channel Field — This field is always the last four characters of line one. It consists of three spaces, a lower case "ch", and the currently selected channel number, if any.

If the current display relates to the system instead of a channel the display will be a space followed by the lower case letters "sys". The field will contain the word "all" if both the system and all channels are selected.

Error Field — The error field is the first 35 characters of line two. This field is used to report errors or warnings. Error messages will remain on the display until a new display is generated. This field is also used to monitor certain functions, however, error messages will always take priority and overwrite any other use of this field.

GPIB Field — The last five characters of line two make up the GPIB display field which is used to display the status of the GPIB interface. The first two characters of the field are always spaces. The last 3 characters will contain any of the following upper case letters:

1. "R" which means remote.
2. "L" which means listen or "T" which means talk.
3. "Q" which means service request.

Menu Description Field — The third line describes the menu parameters controlled by the function keys F1 through F6 and as annotated on line four of the display

Function Key Labels — The last line of the display provides labels for the function keys located directly below the display. Each of the front panel function keys (F1 through F6) has a matching segment of the label field linked to it. Each label field is up to 6 characters long with the exception of the F6 label which is limited to five characters. All of the label fields are separated by one space.

3.4 POWER SWITCH

The front panel Power switch shuts off the Model 869 by disabling the internal switching power supply but does not remove AC power from the power supply module. To operate the Power switch, press and release it. Table 3-2 describes the Power switch operation.

3.5 NUMERIC KEY AND CURSOR CONTROL

The Numeric Keypad and Cursor controls that are located on the right side of the front panel are used for the

selection of mainframe/channels and the selection and entry of numeric data. These controls:

- 1. Simplify data selection by minimizing keystrokes.
- 2. Allow continuous variation of output parameters (frequency, for example) during operation.
- 3. Allow entry of positive or negative numbers in decimal or scientific notation.

Refer to figure 3-3 for detailed descriptions of the Numeric Keypad and the Cursor controls.

Table 3-2. Power Switch Operation

Position	Effect	Power LED
Standby	The 869 ceases to operate.	Not illuminated
On	Enables the 869 power supply. Instrument begins to operate.	Illuminated

Table 3-3. Numeric Keys and Cursor Operation

Control	Operation/Function
0 thru 9	The 0 through 9 keys allow the entry of fixed numbers (such as 5 or 25892 etc.). To continuously vary a parameter (e.g., to change continuously from 5 to 100), use the cursor knob or cursor arrows.
. (Decimal Pt)	The . (decimal) key inserts the decimal point in decimal numbers (such as 147.63).
± (Plus/Minus)	The ± (Plus/Minus) key changes the sign of the numeric entry.
Clear	The Clear key erases current parameters only.
Exponent	The Exponent key allows entry of exponential values. For example, 1,000,000 can be entered as 1, Exponent, 6. That is, 1,000,000 is the same as 1 X 10 ⁶ .
Cursor Controls	The Cursor knob and direction arrows can vary the parameter values continuously and step through the numbered menu choices. For example, if a channel output frequency is being set, the display will indicate the current value for the frequency. Use the Left/Right cursor arrows to position the cursor on the display under the digit in the frequency to be changed. This digit can be incremented or decremented by using the up or down cursor arrows; the entire value of the frequency can be changed by using the cursor knob. Because the cursor knob and cursor keys change both the parameter and send an execute command at the same time it is not necessary to press the Execute key to enter new values selected with the knob/cursor controls.

3.6 EXECUTE KEY

The Execute key causes the Model 869 to accept (make the current parameters change to the new parameters) numbers entered on the numeric keypad as the and all system parameters are updated to the latest values. For example, if a channel output frequency is being set, the

display will indicate the current value for the output frequency. The frequency can be changed by entering a new value with the numeric keypad and then by pressing Execute. Press EXECUTE after each parameter value entry or at the end of a group of parameter value entries.

3.7 F KEYS (F1 THRU F6)

Pressing the **Channel Select** key and the number on the **numeric keypad** that is associated with the desired pulse generator channel number (as shown on the instrument front panel display) presents the user with a set of labels for function keys **F1** thru **F6**. Some F keys may or may not have labels assigned to them depending on the parameters being selected. The set of labels last used for the mainframe or a channel will always reappear when reselecting the mainframe or that channel.

						sys
----- system menu -----						
util	gpib	config				
F1	F2	F3	F4	F5	F6	

The menu labels that appear on the LCD display when a front panel key is pressed define the **function** of keys **F1** through **F6**. Some labels provide the associated F keys with sub-menus that assign new labels to the F keys.

3.8 CHANNEL SELECT KEY

Control of individual channels or the Mainframe begins by pressing the Channel Select key and a number from the numeric keypad to gain access to the desired channel/mainframe top level menu. When only the Channel Select key is pressed, the display will list all of the installed channels and their positions. Empty channel positions are indicated by blank lines.

1: CH1 PULSE GEN master

When using the numeric keypad to enter a number selected from the channel menu you are restricted to 0, 9, and installed channels. Valid numbers that can be used are zero (0) for the mainframe, one (1) through four (4) for the channels, and nine (9) for all of the channels as a group. When zero is selected, the word "sys" will appear in the upper right corner of the display. If one of the four channel numbers is selected, one of the character groups "ch1" thru "ch4" will appear. When nine is selected, the word "all" will appear in the upper right corner.

						sys
----- system menu -----						
util	gpib	config				

						ch1
-- outputs --						-- pulse polarity --
OFF on			NORM compl			

CH1 PULSE GEN master	all
----------------------	-----

3.9 RESET KEY

3.9.1 Mainframe Reset

Pressing the Reset key with the Mainframe (sys) selected will present a menu with only one selection (reset) available. Pressing the F1 key to start the reset program, as indicated by the display menu selection changing to all caps, and resets only the mainframe.

3.9.2 Channel Reset

If one of the channels was selected prior to pressing the Reset key, a different menu will be presented. Pressing the Reset key with channel 1 selected will cause the following display.

						ch1
- pulse reset -						
reset abort						

Pressing the F1 key (reset) initiates the reset. After the channel is reset, the display will appear as follows:

						ch1
reset operation completed						
- pulse reset -						
RESET abort						

If "all" was selected by entering a "9" on the numeric keypad, then all of the channels and the mainframe would have been reset. The Reset key resets all of the channel parameters to the power-up conditions as shown in the following list:

						all
- global reset -						
soft hard						

1. Frequency: 1 kHz
2. Function: Square.
3. Upper Level: 0.5V
4. Lower Level: -0.5V
5. Mode: Continuous.
6. Leading Trans: 1 ns
7. Trailing Trans: 1 ns
8. Burst Count: 2
9. Pulse & Sync Out: Off.
10. Sync Out: Clock
11. Pulse Width: 5 ns
12. Pulse Delay: 20 ns
13. Polarity: Positive.
14. Configuration: Indep.
15. Trig Input: External.
16. Trig Slope: Positive.
17. Trig Output: Off.
18. Trig Level: 1.6V

3.10 CAL/TEST KEY

The Cal/Test key provides mainframe (Self-test only) and channel (automatic calibration and Self-test) testing for both individual testing of a single channel or the mainframe or global testing of all installed channel modules and the mainframe.

The global automatic calibration or self-test for channels only is performed by sending the appropriate calibration or self-test command to each channel in succession, starting with the channel #1 module and continuing with channel 2 thru channel 4. When the complete series of channel commands are finished, the global calibration or self-test ends with a global summary on the front panel display.

3.10.1 Mainframe Cal/Test

The Cal/Test key mainframe menu tree is shown in figure 3-2. Use this tree in conjunction with table 3-4, Mainframe Cal/Test Selections, which describes the operation of the function keys **F1** and **F2**.

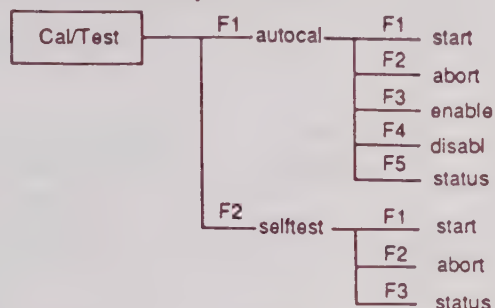


Figure 3-2. Mainframe Cal/Test Menu Tree

The system autocal function performs a calibration of the 10 MHz reference source on the Ref/Cal board. System self-test will test selected circuit groups in the mainframe and the three removable mainframe plug-in cards, the VME board, Ref/Cal board, and front panel display board for correct operation.

Table 3-4. Mainframe Cal/Test Selections

Top Level	Second Level	Description
F1 slftst	F1 start	Pressing F1 on the Cal/Test menu will cause the instrument to select Self-test for the Mainframe circuits. Initiates a Self-test of the Pulse Generator Mainframe. As each function is tested it is displayed on either the first line and/or second line of the display and the measured result being displayed only on the second line. Internal trigger test 5.0000e+00 Hz sys 5.0000e+00 Hz test passed ----- self test ----- START abort status If any function does not pass Self-test, the failed function will be logged into the instrument memory and the testing will continue. When the entire test is finished, the display will show the status of the test on line one. Refer to paragraph 3.26.4 for a list of the Self-test status (error) codes. Self test status: d5f sys ----- self test ----- START abort status

If Self-test is completed successfully, the display will appear similar to the following example.

```

Self test status: 00h                                sys
----- self test -----
START  abort  status
  
```

F2 abort
F3 status

Manually aborts the Self-test process at the first program breakpoint.

Displays the status of the last completed Self-test.

```

selftest status: 00h                                sys
----- self test -----
start  abort  STATUS
  
```

3.10.2 Channel Cal/Test

The Channel Cal/Test key menu tree is shown in figure 3-3. Use this tree in conjunction with table 3-5, Channel Cal/Test Controls, which describes the operation of the function keys **F1** through **F5** when selecting either autocal, self-test, or qcal from the Cal/Test menu.

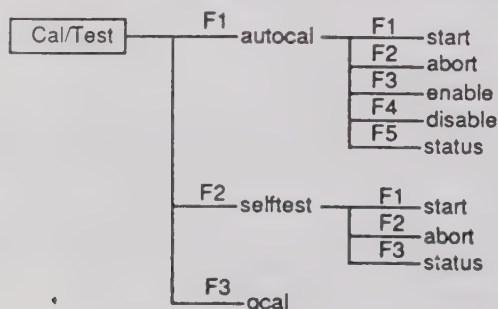


Figure 3-3. Channel Cal/Test Menu Tree

The Cal/Test menu allows automatic calibration (AutoCal), self-test, or quick calibration (Qcal) of a selected channel or channels (global). It also provides for performing a self-test of the system functions when the mainframe is selected.

The channel Cal/Test menu allows:

1. Automatic calibration (AutoCal) of currently selected channel(s) to manufacturers specification.
2. Automatic functional test (Self-test) of the currently selected channel(s).
3. Automatic quick calibration (Qcal) of the selected channel(s) current parameters.

Selection of the Cal/Test menu defines the Function keys **F1** thru **F3** to allow selection and control of the calibration

or test of the currently selected channel or **F1** for the mainframe.

AutoCal Overview

The automatic calibration process tests each parameter for accuracy and develops correction factors to offset any errors. These correction factors are in the form of digital values and are stored in the Model 869 battery backed-up memory for the AutoCal data base; the system firmware uses these digital values to adjust the accuracy of parameters. Part of the data base is a set of nominal values for each parameter which can be substituted for correction factors developed during an AutoCal process.

NOTE

Calibration accuracy may be degraded if the system has had an AutoCal based on an external 10 MHz reference, and then the system is switched to the internal reference.

In the Pulse Generator, the output levels, transition times, pulse delay and pulse width parameters are automatically calibrated. Automatic calibration of the Pulse Generator module is recommended at least once every nine months and also required whenever the module is changed to another slot in the Model 869 System Mainframe chassis, after repair, or if the ambient temperature has changed more than 5°C since the last AutoCal was performed.

Self-test Overview

Self-test will test selected circuit groups in the mainframe and the three removable mainframe plug-in card, the VME board, Ref/Cal board, and the front panel display board for correct operation.

Quick Cal Overview

Pressing the Quick Cal key will not produce a menu tree but will begin the "quick" automatic calibration of the selected channel. When the key is pressed the instrument will begin the Quick Cal routine, produce a message on the display indicating that the routine is in progress, and open all output relays until calibration is complete. If an error occurs during the calibration, that

malfunction will be shown on line two in addition to the error code on line one.

This calibration, in contrast with the normal AutoCal routine, holds its tolerance only for the current settings; if any of the settings are changed, that setting and other dependent settings are no longer calibrated and revert to the AutoCal data base value

Table 3-5. Channel Cal/Test Selections

Top Level	Second Level	Description
F1 autocal		Pressing F1 on the Cal/Test menu will cause the instrument to select the AutoCal function and to display the following menu: ch1 ----- pulse generator autocal menu ----- start abort enable disable status Use the Function keys as described below to initiate the desired action.
	F1 start	Pressing F1 (start) starts the AutoCal process. During the automatic calibration, the second line of the display will indicate the parameter under test. autocal in progress 2 min required ch1 calibrating amplitude level ----- pulse generator autocal menu ----- START abort enable disable status After approximately two minutes (for a successful AutoCal) the display will indicate "autocal completed" on the first line and the date, time and status code for the just completed AutoCal on the second line. Refer to paragraph 3.26.3 for a list of the AutoCal status (error) codes. autocal complete ch1 date:25-mar-88 time:17:45 status:0 ----- pulse generator autocal menu ----- START abort enable disable status If a function fails during the testing, that function will be shown on line two and the AutoCal program will abort. Until the problem with the failed parameter is resolved, the AutoCal process will not be resumed. autocal aborted ch1 min upper lvl error -4.00e+00, 27366 ----- pulse generator autocal menu ----- START abort enable disable status

F2 abort	Manually aborts the AutoCal process at the completion of the current AutoCal step. The AutoCal data base will keep the data from the previous AutoCal.
F3 enable	Activates the AutoCal data base if it has been previously disabled. The Pulse Generator will use the calibration data in memory to set up parameters.
F4 disable	Deactivates the AutoCal data base and substitutes nominal values from memory, as if the Model 869 had been powered up for the very first time and no AutoCal had ever been performed.
F5 status	Pressing F5 from the AutoCal menu selections displays the status of the last AutoCal.

```

last cal:25-MAR-88 17:45 status: 0  ch1
autocal currently enabled
----- pulse generator autocal menu -----
start abort enable disable STATUS  -

```

If the previous AutoCal was not successful or there is a problem running AutoCal, the display will indicate an error message or messages.

```

last cal:5-MAR-88 7:45 status:8000  ch1
autocal currently not enabled
----- pulse generator autocal menu -----
start abort enable disable STATUS  -

```

F2 slftst

Pressing **F2** on the Cal/Test menu will cause the instrument to select Self-test. The Self-test process tests each function for proper operation. The first line in the display will indicate the amount of time that is required to perform the Self-test. The second line will indicate which function is being tested.

F1 start

Initiates a Self-test of the selected Pulse Generator channel. As each function is tested it is displayed on the second line of the menu display.

```

selftest in progress 1 min. required  ch1
testing transition time
----- pulse generator selftest menu -----
START abort status

```

If any function does not pass Self-test, the failed function will be logged into the instrument memory and the testing will continue. When the entire test is finished, the display will show the status of the test on line one. Refer to paragraph 3.26.2 for a list of the Self-test status (error) codes.

```

selftest status: d5f                      ch1
----- pulse generator selftest menu -----
START abort status

```

		If Self-test is completed successfully, the display will appear similar to the following example. <pre>selftest status: 0 ch1 - - - - - pulse generator selftest menu - - - - - START abort status</pre>
	F2 abort	Manually aborts the Self-test process at the first program breakpoint.
	F3 status	Displays the status of the last completed Self-test.
		<pre>selftest status: 0 ch1 - - - - - pulse generator selftest menu - - - - - start abort STATUS</pre>
F3 qcal		This key allows the channel to be quick calibrated for the highest possible accuracy using the currently selected parameters. This calibration is valid only as long as the current parameters are not changed.

3.11 STATUS KEY

The status key presents the user with an abbreviated list of the current parameters for the currently selected channel. If the Model 869 was just turned "on" or it was just reset, then the displayed parameters will be the channel default parameters.

```
PER:1.0000mS  LE:1.00nS  square  ch1
DLY: - - - - -  TE:1.00nS  continuous
WID: - - - - -  UL:500.mV  master
TRGLVL:1.6V   LL:-500.mV  off,norm
```

If the Channel Select key was used to enter a global mode the display will only indicate the installed modules. If the Channel Select key was used to select the system, the key will be inoperative.

Some of the entries in the status display may be missing depending on the current selected parameter settings. For instance, if squarewave operation is selected then the delay and width parameters will be blank.

If a class II error (an error other than a single limit error) is present in the instrument when the status key is pressed, an error message indicator (ERR) will flash on the fourth line directly above the F-6 key. Pressing the F-6 key and holding it will display the error condition on the first line and information on how to remove the error on the second and third lines. The bottom line may contain additional notes concerning the error.

3.12 STORE/RECALL KEY

This feature saves (remembers) the settings of an individual channel, or the system specific settings, or "globally" save all of the channels and the system as one "global" stored setting. These settings are saved when the Model 869 is turned off. When the Model 869 is turned back on, the saved setting(s) can be recalled.

There are two groups of stored settings used in the Model 869. These settings are:

Individual: 1 thru 99 settings are provided for storing either an individual channel, or the system specific parameters.

Global: 1 thru 9 settings are provided for collectively storing all of the channels and system specific parameters.

Saving the settings for the entire 869 requires up to 5 assignment numbers (depending on the number of installed modules) of an available 99; saving the settings of just a particular channel or just the system parameters alone requires 1 assignment number for each setting saved. The Model 869 will display a limit error when there is not enough memory left to complete a stored setting operation.

Figure 3-4 shows the Store/Recall menu tree; use the tree in conjunction with table 3-6 to use the Store/Recall feature. Table 3-6 shows how the function keys F1 through F6 are defined when the Store/Recall menu is called.

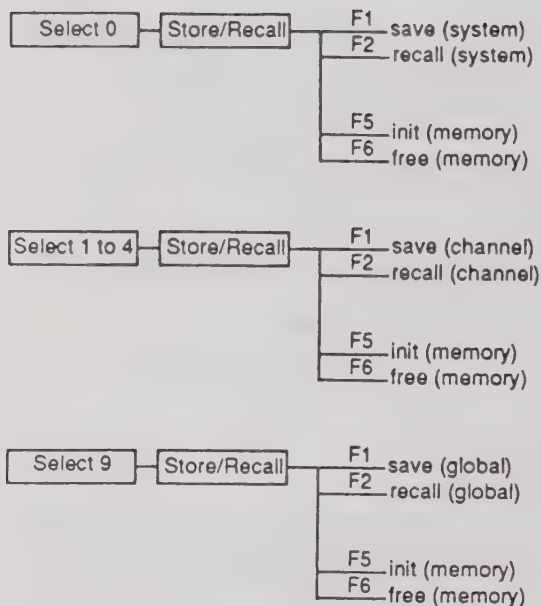


Figure 3-4. Store/Recall Menu Tree

NOTES

When saving parameters to memory it is necessary for the user to keep a record of the stored settings being entered. There is no way (after the setting is stored) to identify the contents of one setting from another setting except by the number or by recalling the setting and reviewing the settings.

A setting saved as a global setting cannot be recalled as a channel setting nor as a system setting. The same restriction applies to both the channel settings and system settings.

If a channel module is moved from one slot to another slot, or is removed, or another channel module is installed, the stored setting memory must be re-initialized by pressing the F5 function key from any one of the stored setting menus.

There are only 99 memory locations available for the combination of global and individual settings. You can determine the number of memory locations by using the following formula:

$(\# \text{ of Global settings}) \times (\# \text{ of channels}) + 1 + (\# \text{ of individual settings})$.

Table 3-6. Store/Recall Menu Selections

Top Level	Second Level	Description
F1 save		Prepares the instrument to save the current parameters of the selected channel, the mainframe or all of the channels and mainframe depending on the "Select Channel" key usage prior to pressing the Store/Recall key. Channel one is shown as selected in the following illustration. Use the numeric keypad to enter the desired setting number and then press execute to save the parameters. By entering a stored setting number as a negative, that stored setting will be deleted and its memory location will be free for future use. <i>Note: The cursor control and the arrow keys should not be used to enter numbers when saving or recalling stored settings. Each time the cursor control or arrow key is changed and a number displayed, an execute command is automatically sent. This causes each number displayed to have a setting saved to or recalled from memory.</i> individual store setting: 1 ch1 - channel - - memory - SAVE recall init free
F2 recall		Prepares the instrument to recall the parameters saved in a numbered stored setting. Use the numeric keypad to select the desired stored setting number and then press execute. individual store setting: 1 ch1 - channel - - memory - save RECALL init free

F5 init		Pressing this key prepares the instrument to initialize (or clear) all of the RAM associated with the stored setting. This includes RAM assigned to the channel settings, system settings, and global settings.
	F1 yes	Initializes (clears) the stored settings RAM of data and garbage.
	F2 no	Aborts the initialization process.
F6 free		This key displays the number of memory settings that remain and the number that have been used

3.13 MANUAL TRIGGER KEY

The Manual Trigger key provides a source for a user supplied single trigger or gating pulse (holding the key pressed) input to any or all channels and to the system. When this key is pressed, the system or selected channel will receive a trigger command. (No display response)

Channel 0 or 9 selected.

When the Manual Trigger key is pressed a trigger signal is induced onto the System Trigger bus (STRIG). All of the channels and the system (select 9) or the system (select 0) must be configured to trigger from the system trigger bus.

Channel 1 thru 4 selected.

When the Manual Trigger key is pressed a trigger command is sent to the trigger circuits of the se-

lected channel. To use this signal the selected channel need not have the internal trigger selected but cannot be in the continuous mode of operation.

For more information on the usage of the System Trigger bus (STRIG) configuration, refer to paragraph 3.19, Trig/ Sync Key operation and paragraph 3.23, System Configuration Menus.

3.14 OUTPUT KEY

Displays new labels for function keys **F1** thru **F5** that allows the user to control both the **Pulse Out** output relay and the **Sync Out** relay.

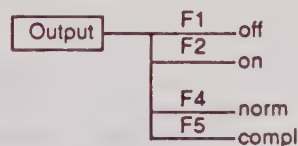


Figure 3-5. Output Key Menu Tree

Table 3-7. Output Key Menu Selections

Top Level	Description
F1 off	Opens the Pulse Out and Sync Out output relay contacts, disabling both outputs. <i>Note: The Sync Out relay can also be opened independently by using the Sync menu.</i>
F2 on	Closes the Pulse Out and Sync Out output relay contacts, enabling the output. <i>Note: The Sync Out relay can also be closed independently (if the Pulse Out relay is already closed) by using the Sync menu.</i>
F4 norm	Select the polarity of the Pulse Out signal with this key. When pulses are being generated, their pulse top voltage levels (upper level) will be positive with respect to the base line voltage (lower level).
F5 compl	Select the polarity of the Pulse Out signal with this key. When pulses are being generated, their pulse top voltage level (lower level) will be negative with respect to the base line voltage (upper level).

3.15 LEVEL KEY

The "level" key displays new labels for the function keys **F1**, **F2**, **F4**, and **F5**. This allows the user to set both the upper and lower **Pulse Out** waveform levels. It also allows the user to enable and disable the output attenuator. Figure 3-6 shows the Level key menu tree and table 3-8 describes each function key in detail.

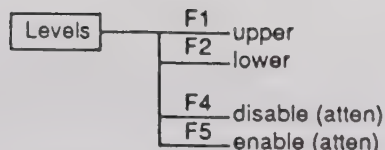


Figure 3-6. Level Key Menu Tree

Table 3-8. Level Key Menu Selections

Top Level	Description
F1 upper	When pressed, the display will show the current value for the Pulse Out output upper voltage level. Use the numeric keypad or the Cursor keys to enter a new value for this parameter.
F2 lower	When pressed, the display will show the current value for the Pulse Out output lower voltage level. Use the numeric keypad or the Cursor keys to enter a new value for this parameter. <i>Note: The combination of upper and lower levels cannot exceed an amplitude of 10 Vpp (Upper - Lower).</i>
F4 disable	Will disable the operation of the output attenuator when pressed, forcing the output levels to the X1 range. Provides the fastest possible transition times (when programmed to <3 ns), but limits the output voltages to those allowable in the X1 range (see figure 1-5).
F5 enable	Will enable the operation of the output attenuator when pressed. This allows for output levels in the X1 to X8 ranges (see figure 1-6). Minimum transition times will not be the fastest possible.

3.16 TIMING KEY

When selected, the display will show new labels for function keys **F1** thru **F6** as indicated in the menu tree shown in figure 3-7. Table 3-9 gives a detailed description of the function keys shown in the menu tree. These function keys allow the user to select and change the desired channel timing parameters.

Note: Pulse repetition rate can be programmed in terms of frequency or period.

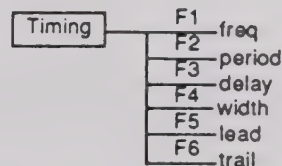


Figure 3-7. Timing Key Menu Tree

Table 3-9. Timing Key Menu Selections

Top Level	Description
F1 freq	To change the Pulse Out output frequency, press this key and then use the numeric keypad or Cursor controls to enter the desired new frequency. Enter the value in Hertz or in exponential form (i.e., if 1 kHz is desired, enter 1 Exponent 3 Execute).
F2 period	To change the Pulse Out output period, press this key and then use the numeric keypad or Cursor controls to enter the desired new period. Enter new the value in seconds or in the exponential form (i.e., if a period of 1 ms is desired, enter 1 Exponent - 3 Execute).
F3 delay	To set the delay parameter, press F3 and use the numeric keypad, the Cursor controls, or the knob to enter the new value. When generating single pulses "delay" sets the amount of time between the Sync Out and the Pulse Out pulse leading edges (see paragraph 2.11.3, Pulse Definitions). When generating double pulses "delay" sets the amount of time between the period start and the leading edge of the second pulse.

F4 width	Use this selection to set the width of the Pulse Out pulses. Enter the new value using the numeric keypad or the Cursor controls.
F5 leading	Use this selection to set the leading edge transition time of the pulses. Enter the new value using the numeric keypad or the Cursor controls.
F6 trailing	Use this selection to set the trailing edge transition time of the pulses. Enter the new value using the numeric keypad or the Cursor controls.

3.17 FUNCTION KEY

Displays new labels for function keys **F1** thru **F3** that allow the user to select the Pulse Generator output function. From the descriptions listed below, select the desired function.

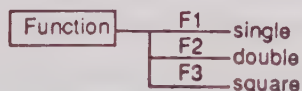


Figure 3-8. Function Key Menu Tree

Table 3-10. Function Key Menu Selections

Top Level	Description
F1 single	Select this to have the channel generate one pulse of user definable waveform, and delay from period beginning, for each period.
F2 double	Select this to have the channel generate two pulses of user definable waveform and separation by the selected delay for each period.
F3 square	Provides one 50% duty cycle pulse each period.

3.18 MODE KEY

The display will show new labels allowing the user to select the desired mode of operation. Press one of the six keys to choose the appropriate mode.



Figure 3-9. Mode Key Menu Tree

Table 3-11. Pulse Generator Menu Selections

Top Level	Description
F1 cont	Select this key to have the Pulse Generator generate pulses continuously.
F2 trig	Select this key to generate pulses only on the event of a valid selected trigger. <i>Note: Not allowed in squarewave function.</i>
F3 sgate	Sets the channel to the "synchronous gated" waveform mode. This allows pulses to be generated only as long as the selected trigger is valid. If the selected trigger terminates prior to the waveform period end, the remaining portion of the period is generated at which time generation stops.
F4 agate	Sets the instrument to the "asynchronous gated" waveform mode. This allows pulses to be generated at the output only as long as the selected trigger is valid. Output is terminated at the instant that the selected trigger becomes invalid.

F5 burst	Use this selection to generate a specified number of waveform periods for each valid trigger. Enter the specified number in response to the burst "count" prompt which is generated after the Burst key is pressed. The selected burst will be generated only in the event of a valid selected trigger.
F6 extwid	When this feature is selected, a valid external trigger signal from the module Trig In connector is applied to the Pulse Out connector. <i>Note: The pulse output levels and transition times will be as programmed on the Pulse Generator.</i>

3.19 TRIG/SYNC KEY

This front panel key allows the user access to the channel menus controlling the use of the System Trigger (STRIG) bus, the System Sync (SSYNC) bus, and the master/slave selection keys.

Three categories of trigger/sync operation can be selected:

1. The trigger input or output for one or more channels.
2. The sync output for one or more channels.
3. Selection of master, slave, or independent sync operation.

Figure 3-10 shows the Trigger/Sync key menu tree. Use the tree in conjunction with table 3-12 which shows how the function keys **F1** thru **F6** are defined when the Trigger/Sync key menu is called.

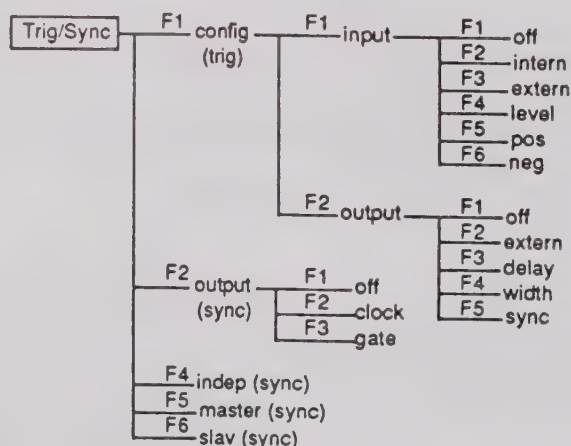


Figure 3-10. Trigger/Sync Key Menu Tree

Table 3-12. Trig/Sync Menu Selections

Top Level	Second Level	Third Level	Description
F1 config	F1 input		Displays new labels for function keys F1 thru F6 that allows the user to set the instrument configuration.
		F1 off	Provides the user with the choice of setting either the trigger inputs (F1) or the trigger outputs (F2). <i>Note: Output to the internal STRIG bus only.</i> When this key is pressed, the user is given the choice of selecting either "Internal" or "External" inputs for triggering the Pulse Generator or of isolating the trigger circuits from all inputs. Press this key to isolate the Pulse Generator trigger circuits from either internal or external trigger inputs or from both inputs.

	F2 output	F2 intern	Press this key to select the internal Mainframe supplied System Trigger (STRIG) as the trigger source for this module.
		F3 extern	Press this key to select the external trigger at the Trig In connector as the trigger source for this channel.
		F4 level	Press this key to display the current Trig In threshold level. This value can be changed using the numeric keypad or the knob/Cursor controls.
		F5 pos	Select the positive transition of the external Trig In input signal as the active edge, and high level for valid gating signal, by pressing this key.
		F6 neg	Select the negative transition of the external Trig In input signal as the active edge, and low level for valid gating signal, by pressing this key.
			When this key is pressed , the user is given the choice of selecting one of the four (4) signals output to the System Trigger bus on the mother-board, or of disabling the output.
	F3 output	F1 off	Disables channel trigger signal output to (STRIG) System Trigger bus.
		F2 extern	The external trigger signal appearing at the module Trig In connector at the rear of the module is applied to the System Trigger bus (if allowed the the Trig In parameter setting) by making this selection.
		F3 delay	The pulse from the delay output is applied to the System Trigger bus, and its width is equal to the programmed delay.
		F4 width	The pulse from the Width output is applied to the System Trigger bus, and its width is equal to the programmed width.
		F5 sync	The signal appearing at the module Sync Out connector is applied to the System Trigger (STRIG) bus when this key is pressed.
			Use this key to select a new menu to control the output signal appearing at the Sync Out connector. The display will show new labels for keys F1 through F3 . See the descriptions below and make the desired selection.
		F1 off	Disconnects the Sync Out connector.
		F2 clock	Sets the Sync Out signal to have a 50% duty cycle for each period.
		F3 gate	Select "gate" to drive the Sync Out signal to a logic high whenever pulses are being generated at the Pulse Out connector.
F4 indep		Configures the channel for independent operation. In independent operation the channel provides no signal to and uses no signal from the System Sync (SSYNC) bus.	
F5 master		Provides the same signal that appears at the module Sync Out BNC connection to the System Sync (SSYNC) bus and therefore it can be used as the frequency clock source by other channels.	
F6 slave		Forces the channel to use the System Sync (SSYNC) bus as its main clock reference. Allows another channel, (selected as Master) or the signal from the Mainframe Sync In, to be the clock source over the bus.	

3.20 SYSTEM RESOURCE MENUS

Pressing the Channel Select key followed by the numeric keypad "0" key defines the F keys **F1** through **F6** to allow selection and control of the system resources. This main menu for the system allows access to the menus that

control the system utilities (paragraph 3.21), system GPIB controls (paragraph 3.22), and the Mainframe (system) configuration menus (paragraph 3.23). Figure 3-11 shows only the top levels of the system resource menus. Detailed descriptions of the menus and menu trees can be found in the following paragraphs.

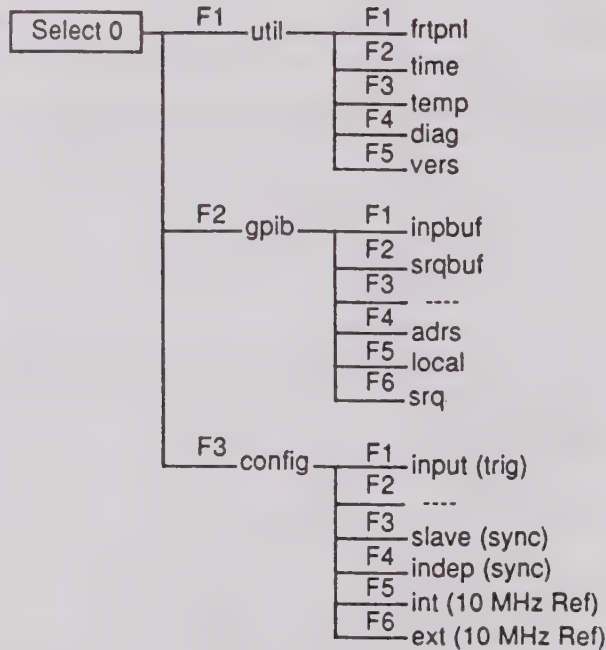


Figure 3-11. System Menu Tree

3.21 SYSTEM UTILITY MENU

The Utility menu, as shown in figure 3-11, allows you to control:

1. Whether or not an audible beep is generated upon the closure of a front panel key.
2. The viewing angle (contrast) and backlighting of the LCD display.
3. The time and temperature logging functions of the Model 869.
4. Access to the Maintenance Diagnostics.
5. To display the software version of the Ref/Cal board ROMs

The Utility menu also allows access to diagnostic functions.

3.21.1 Utility Front Panel Menu

This selection from the System Utility menu allows control of the front panel beeper, the viewing angle (contrast), and the LCD backlight.

Table 3-13 describes the operation of the individual keys **F1** through **F3** when defined by the Utility front panel menu. After selection of the System Utility key, the front panel utilities control selections can be made.

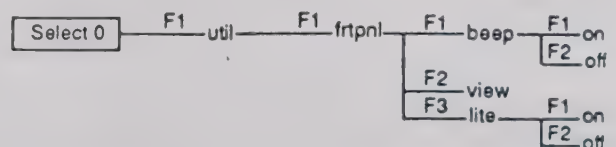


Figure 3-12. Utility Front Panel Menu Tree

Table 3-13. Utility Front Panel Menu

Top Level	Second Level	Third Level	Description
F1 frtpnl	F1 beep		Selects the front panel utility control menu.
			Selects control of the front panel beeper. Pressing this key will cause the display to define the function keys F1 and F2 for turning off or on the beeper as described below.
		F1 on	When the Model 869 is first turned on, the beeper sounds every time a front panel key is pressed. This key turns turns the beep feature on if it has been previously turned off.
		F2 off	This key turns the front panel beeper off; beeps will not sound each time a front panel key is pressed.
	F2 view		Make this selection to adjust the viewing angle (contrast) of the front panel liquid crystal display (LCD). Use the front panel knob/cursor controls to optimally adjust the viewing angle.
			This key allows selection of the LCD backlight. Use the F1 or F2 keys as described below.
	F3 lite	F1 on	This key turns on the backlight for the front panel LCD.
		F2 off	This key turns off the backlight for the front panel LCD.

3.21.2 Utility Time Menu

The ROM-based software in the Model 869 Mainframe keeps track of:

1. The month, day and year.
2. The current time of day.
3. The value of the elapsed time counter.
4. The amount of time that the Model 869 has been on since the last cycle of the front panel Power Switch to On.
5. The date and time of the last complete automatic calibration.
6. The amount of elapsed time since the time was last set.

Table 3-14 describes each of the Utility Time functions and their associated keys. The time controls can be accessed by performing the key sequence as shown in figure 3-13.

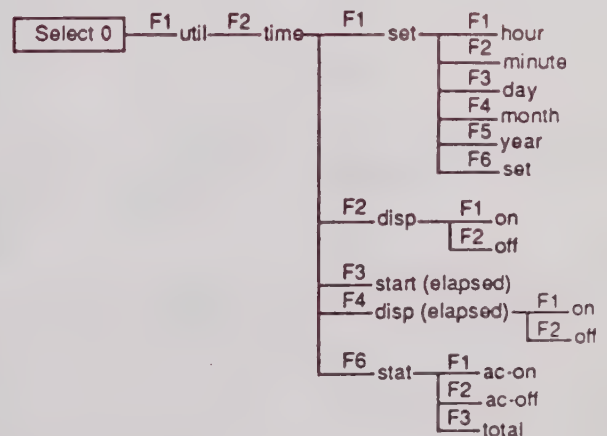


Figure 3-13. Utility Time Menu Tree

Table 3-14. Utility Time Menu

Top Level	Second Level	Third Level	Description
F2 time	F1 set		This key selects the time utilities menu.
			This key allows the user to set the correct time of day and the correct calendar date. Use the function and cursor keys as described below to make the entries.
		F1 hour	Press this key and then use the front panel knob or cursor controls to enter the current hour.
		F2 minute	Press this key and then use the front panel knob or cursor controls to enter the current minute.
		F3 day	Press this key and then use the front panel knob or cursor controls to enter the current day.
		F4 month	Press this key and then use the front panel knob or cursor controls to enter the current month.
		F5 year	Press this key and then use the front panel knob or cursor controls to enter the current year.
		F6 set	After entering desired choices for the current time and date, press this key to change the current time and date to the values just entered using the F1 through F5 keys above.
	F2 disp		Allows selection of whether or not the current time and date are continuously displayed on the LCD display. The function keys F1 and F2 are used to make this selection as described below.
		F1 on	Turns on the display of the current time and date.
		F2 off	Turns off the display of the current time and date.
	F3 start		Immediately clears the contents of the elapsed time counter and immediately starts it running. The resolution of the elapsed time counter is 1 second and the range is 999 days.
	F4 disp		Allows selection of whether or not the elapsed time and date are continuously displayed on the LCD display. The function keys F1 and F2 are used to make this selection as described below.
		F1 on	Turns the display of the elapsed time on.
		F2 off	Turns the display of the elapsed time off.
	F6 stat		Selects the time statistics controls described below.
		F1 ac-on	Displays the amount of time elapsed since the Model 869 was last turned from Standby to On.
		F2 ac-off	Displays the total time the Model 869 has been turned off.
		F3 total	Displays the total time elapsed since the time was last set by the user.

3.21.3 Utility Temperature Menu

The Model 869 always monitors its internal temperature and will generate a warning when the internal temperature reaches 50°C. The utilities menu can be used to select for display the internal cabinet temperature, the maximum temperature excursion, and the minimum temperature excursion. A selection in this menu also

allows clearing the maximum and minimum temperature record so that new minimum and maximum values can be stored from the time the clear selection is made.

Table 3-15 describes how the function keys **F1** thru **F6** are defined to control the temperature logging functions. The temperature controls can be accessed by performing the key sequence as shown in figure 3-14.

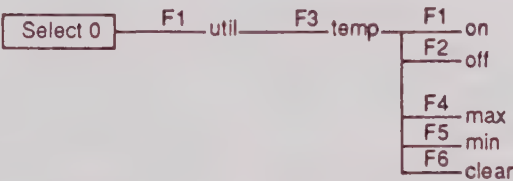


Figure 3-14. Utility Temperature Menu Tree

Table 3-15. Utility Temperature Menu

Top Level	Second Level	Description
F3 temp		Selects the temperature utilities menu. Use the function keys as detailed below to have the Model 869 log and/or display its minimum and maximum internal temperatures.
	F1 on	Turns on the display of the Model 869 internal temperature.
	F2 off	Turns off the display of the Model 869 internal temperature.
	F4 max	Displays the maximum internal temperature excursion.
	F5 min	Displays the minimum internal temperature excursion.
	F6 clear	Clears the minimum and maximum temperature records so that the recording process can be started over.

3.21.4 Utility Diagnostic Menu

The Model 869 diagnostic menu is shown here in an abbreviated form only for general information. Usage of these menu selections should be limited to the repair technician when performing maintenance on the Model 869.

Table 3-16 shows how the function keys **F1** thru **F3** are defined to select either the Master board, the Ref/Cal

board, or the channel modules. Selections from this menu can be made by pressing the key sequence as shown in figure 3-15.

CAUTION

Incorrect use of these menu selections can cause extensive damage to this instrument or at least the loss of all of the calibration constants stored in RAM.

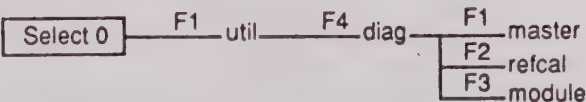


Figure 3-15. Utility Diagnostic Menu Tree

Table 3-16. Utility Diagnostic Menu

Top Level	Second Level	Description
F4 diag		Presents the user with a selection (using F1 thru F3) of either the Master board, the Ref/Cal board, or the installed modules.
	F1 master	Selects the Master Board Diagnostics.
	F2 refcal	Selects the Ref/Cal Board Diagnostics.
	F3 module	Selects the Channel Module Diagnostics.

3.21.5 Utility Version Menu

This menu allows the user to identify the software version contained in the ROM of each of the installed channel modules. It will not give the version of the software contained in the ROM for the System Mainframe modules. Perform the key stroke sequence as shown in figure 3-17.



Figure 3-17. Utility Version Menu Tree

To obtain the software version for the Mainframe Ref/Cal board, perform the key strokes as shown in figure 3-18.

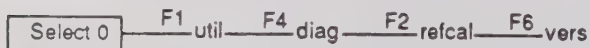


Figure 3-18. Ref/Cal Version Key Sequence

To obtain the software version for the Mainframe VME board, simply turn the Model 869 off for 10 to 15 seconds and then turn it back on. The version of the VME software will appear on the display.

3.22 SYSTEM GPIB MENU

This selection from the System Menu allows control of the GPIB features. This menu allows:

1. Display of the GPIB input buffer contents.
2. Display of the GPIB service request buffer contents.
3. Display and control of the Model 869 GPIB address.
4. Return of the Model 869 to local operation.
5. Generation of a Service Request over the GPIB.

Table 3-17 shows the assignment of the function keys **F1** through **F6** when the GPIB menu is called. To enter this menu, press the Channel Select key followed by the numeric keypad "0" key. The GPIB label will be displayed above the F3 key.

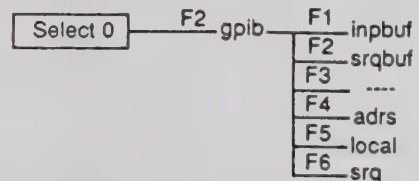


Figure 3-18. GPIB Menu Tree

Table 3-17. GPIB Controls

Top Level	Second Level	Description
F2 gpib		Selects the front panel GPIB controls. The second level selections under this heading appear below.
	F1 inbuf	Displays the contents of the input buffer, including the special control characters <CR>, <LF>, and <EOI>. Rotation of the cursor knob allows the entire contents of the GPIB buffer to be scrolled across the display.
	F2 srqbuf	Displays the entire contents of the service request buffer. Rotation of the cursor knob allows the entire contents of the service request buffer be scrolled across the display. The service request buffer contains a log of all GPIB service requests. Each time a service request is generated, an entry is made to this buffer; reading this buffer over the GPIB clears this buffer.

F4 adrs	Displays the currently selected GPIB address. At power up this is the rear panel GPIB address switch setting.
F5 local	Returns the unit to the local condition if it was in remote and if local lockout was not enabled.
F6 srq	Generates a service request if the service request mask is set to enable service requests from the front panel.

3.23 SYSTEM CONFIGURATION MENU

The "config" selection (**F3**) from the System Menu allows the user access to the menus that control the System Trigger (**STRIG**) parameters, the System Sync (**SSYNC**) parameters and the 10 MHz Reference parameters.

The Model 869 Mainframe can be programmed using the System Trigger menu to internally generate triggers of a selected frequency, or to select an external trigger signal from the rear panel "Trig In" connector. Further, the external trigger slope and level can be selected and be delayed by a user programmed time or number of triggers. The System Trigger bus connects to all of the channel modules. Any channel module can use the System Trigger signal as an input or it can provide a signal to the bus.

Figure 3-19 shows the key stroke combinations necessary to access the System Trigger (**STRIG**), System Sync (**SSYNC**), and 10 MHz Reference selections.

Table 3-18 describes the operation of the individual keys **F1** thru **F6** when defined by the key stroke combination of "select 0", "config", and "trig" that accesses the System Trigger (**STRIG**) menu selections.

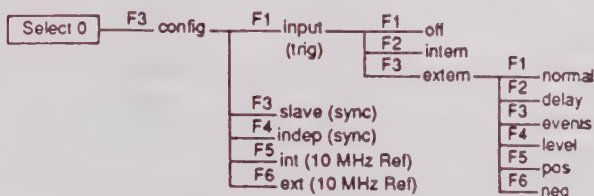


Figure 3-19. System Configuration Menu Tree

Table 3-18. System Config Key Descriptions

Top Level	Second Level	Third Level	Description
F1 input (trig)	F1 off		Calls the trigger menu. Defines the function keys F1 through F3 as follows (second level).
			Disconnects the Model 869 internal trigger source and the external Trig In input from the Model 869 System Trigger (STRIG) bus.
			Connects the internal trigger source to the System Trigger (STRIG) bus and causes the current value of the internal trigger frequency to be displayed. A new value for the trigger frequency can be selected with the Numeric Keypad or the Cursor controls.
	F2 intern		Allows selection of the external trigger signal from the Model 869 rear panel Trig In input. A selection from one of the following third level function keys must be made to select the external trigger function.
		F1 normal	Connects the signal from the external Trig In input to the System Trigger (STRIG) bus.
		F2 delay	The active edge of the external Trig In input is delayed by a time shown on the display before being generated to the System Trigger (STRIG) bus. The amount of this delay can be selected by using the numeric keypad or the Cursor controls

	F3 events	Divides the external trigger frequency from the Trlg In input by the value shown on the display. This number of delay events can be selected with the numeric keypad or the Cursor controls.
	F4 level	Displays the voltage threshold at which the external trigger signal from the Trlg In input becomes recognized. This level can be changed by entering a new value with the numeric keypad or the Cursor controls.
	F5 pos	The external trigger signal from the Trlg In input becomes recognized on its rising edge when this selection is made.
	F6 neg	The external trigger signal from the Trlg In input becomes recognized on its falling edge when this selection is made.

3.23.1 System Sync (SSYNC) Selections

The Model 869 Mainframe can be programmed via the System Menu to disable or select the generation of the signal appearing at the external rear panel **Sys Sync In** connector to the System Sync (SSYNC) bus.

The System Sync (SSYNC) bus is connected to all of the channel modules. Any channel module configured as a slave will synchronize its operation with the signal appearing on the System Sync (SSYNC) bus. Any module

configured as a master will generate pulses to the System Sync (SSYNC) bus.

Figure 3-16 shows the key stroke combinations necessary to access the System Sync (SSYNC) selections.

Table 3-19 describes the operation of the individual keys **F3** and **F4** when defined by the key stroke combination of "select 0" and "config" that accesses the System Sync (SSYNC) menu selections.

Table 3-19. Configuration Sys Sync Mode Menu

Top Level	Description
F2 slave,	Enables the signal from the external Sys Sync In input at the Model 869 Mainframe rear panel to the System Sync (SSYNC) bus.
F3 indep	This selection disables the external Sys Sync In input; the Model 869 Mainframe passes or generates no signals to the System Sync (SSYNC) bus.

3.23.2 10 MHz Reference Selections

The Model 869 Mainframe can be programmed using the System Menu to select either an internal 10 MHz reference or the external reference signal appearing at the 10 MHz Ref In connector on the rear panel.

The 10 MHz reference clock is connected to all of the function modules; this reference clock is used by all of

the channel modules as a timebase for operation.

Figure 3-19 shows the key stroke combinations necessary to access the 10 MHz reference selections.

Table 3-20 describes the operation of the **F5** and **F6** keys when defined by the System menu for selection of the 10 MHz reference.

Table 3-20. 10 MHz Reference Selections

Top Level	Description
F4 int	Selects the internal mainframe 10 MHz reference frequency.
F5 ext	If in tolerance, the external 10 MHz Ref In connector signal from the rear panel is used as a system reference. An out of tolerance external reference frequency will cause the Model 869 to automatically select its internal reference; the appropriate error message will be displayed. Once the external frequency is accepted by the Model 869 Mainframe, it is not monitored for frequency accuracy; the accuracy may drift out of tolerance unrecognized by the Model 869. (Refer to the specifications in Section 1 for ext. ref. frequency tolerance)

3.24 TYPICAL SET-UP EXAMPLES

The following paragraphs give detailed step-by-step procedures in setting up typical operating parameters for the Model 869 Pulse Generator channels.

3.24.1 System Trigger Operation Example

When using the Model 869 System, it is possible to use one channel to trigger another channel located within the same chassis. It is not necessary to use external cables to connect the signal from one channel to the other. The means for providing this mode of operation is the internal System Trigger Bus (STRIG). Any one of the channels can be used to trigger any or all other channels within the same chassis. This example shows how to setup the trigger operation and also to show the differences in timing for trigger sources from different parts of the channel module.

1. System Setup:

- a. A Model 869 Mainframe
- b. Two Model 680-03, Pulse Generator modules installed as Channel 1 (slots 1 & 2) and Channel 2 (slots 3 & 4).
- c. A three-channel oscilloscope.
- d. Interconnect the equipment as follows:
 - Connect the Channel 1 Sync Out connector to the oscilloscope chan 3 input.
 - Connect the Channel 1 Pulse Out connector to the oscilloscope chan 1 input.
 - Connect the Channel 2 Pulse Out connector to the oscilloscope chan 2 input.
- e. Trigger the oscilloscope with the Sync Out signal from Chan.1 Pulse Generator.

2. Reset the entire Model 869 System by,

System Reset: Soft

Resets both the Mainframe and all of the channels installed to the default parameters.

3. Using the Channel Select key and the numeric keypad, select 1 for channel 1, set the following parameters, and then press execute:

Output: On
 Mode: Cont
 Function: Single
 Frequency: 10 kHz
 Delay: 20 μ s
 Width: 40 μ s

4. Using the Channel Select key and the numeric keypad, select 2 for channel 2, set the following parameters, and then press execute:

Output: On
 Mode: Cont
 Function: Single
 Frequency: 199.99 kHz
 Delay: 1 μ s
 Width: 1.5 μ s

5. Observe that the two signals on displayed on Chan 1 and Chan 2 of the oscilloscope are not synchronized.

6. Select the Model 869 channel 1, change the following parameter, and then press execute:

Trigger Output: Sync

Selects the Sync Out signal to apply onto the System Trigger Bus.
 The key press sequence for "Sync" trigger output is: Channel menu, conf, trig, output, and then sync.

7. Select the Model 869 channel 2, change the following parameters, and then press execute:

Mode Sgate
 Trigger Input Intern

Selects synchronized gating and selects the signal input from the internal System Trigger Bus.

The key press sequence for "Intern" trigger input is: Channel menu, confg, trig, input, then intern.

8. Observe that the channel 2 has changed to the Synchronize Gated mode of operation and it is gated "on" by the Sync signal from channel 1. Refer to figure 3-20 for timing relationships.

9. Select channel 1, change the following parameter, and then press execute:

Trigger Output: Delay

Selects the Delay Output signal to apply onto the System Trigger Bus.

The key press sequence for "Delay" trigger output is: Channel menu, confg, trig, output, and delay.

10. Observe that channel 2 is now gated "on" by the delay signal from channel 1. Refer to figure 3-21 for timing relationships.

11. Select Channel 1, change settings to the following, and then press execute:

Trigger Output: Width

Selects the Width Output signal to apply onto the System Trigger Bus.

The key press sequence for "Width" trigger output is: Channel menu, confg, trig, output, and then width.

12. Observe that channel 2 is now gated "on" by the width signal from the channel 1. Refer to figure 3-22 for timing relationships.

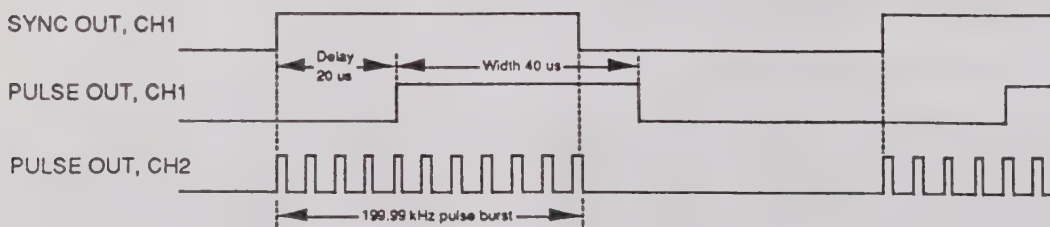


Figure 3-20. Channel 1 Sync Signal to STRIG Bus

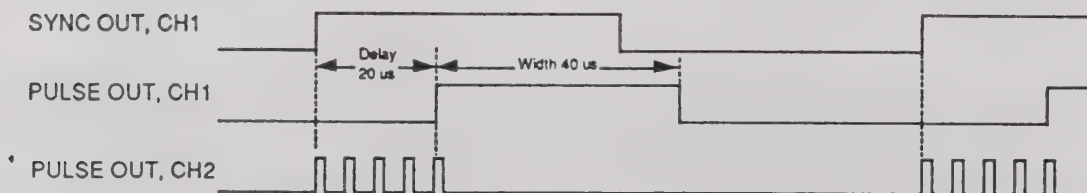


Figure 3-21. Channel 1 Delay Signal to STRIG Bus

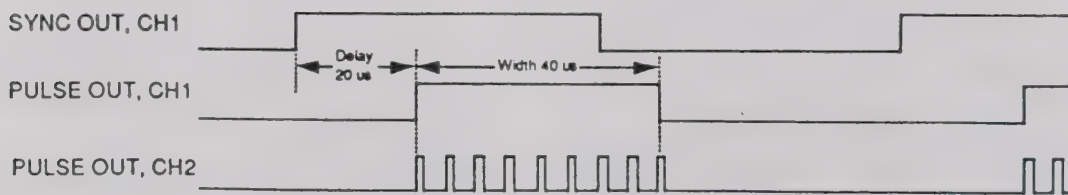


Figure 3-22. Channel 1 Width Signal to STRIG Bus

13. If there is an external trigger signal is connected to the "Trig In" connector of channel.1, the same signal can be applied onto the STRIG Bus by selecting the Trigger Output of channel.1 to be "extern". For example,

Trigger Output: Extern

Selects the signal at the Ext Trig In connector and applies the signal onto the System Trigger Bus. The key press sequence for "Extern" trigger output is: Module menu, conf, trig, output, and then extern.

14. In the above examples, channel.1 is set to the sgate mode. The same setup procedures will work if channel 1 is set to either the trig, agate, burst or extwid modes.

3.24.2 Master/Slave Example

The main purpose of the Master and Slave mode of operation is to provide synchronization of frequency and timing when using two or more channels contained within the same chassis. By using the System Sync input/output connectors and buffer amplifiers, an almost unlimited number of mainframes can be synchronized together for multi-channel applications.

NOTE

The Master/Slave mode of operation works in conjunction with the System Sync Bus (SSYNC) which is a bus on the motherboard of the mainframe. It connects all four channels in parallel. This allows any channel installed in the same mainframe to send clock signal to or to receive clock signals from any other channel via the motherboard SSYNC Bus.

Mainframe and module requirements:

- 1 Model 869 System Mainframe
 - 1 Model 680-03 Pulse Generator, installed in slots 1 & 2.
 - 1 Model 680-03 Pulse Generator, installed in slots 3 & 4.
1. Interconnect the required test equipment as shown in figure 3-23
 2. Reset the entire Model 869 system:

Channel Select 9 Reset Key Soft (F1) Yes	Selects a global function. Selects global reset menu. Verifies that a reset is desired. Performs a global reset of the mainframe and all modules that are installed.
---	---

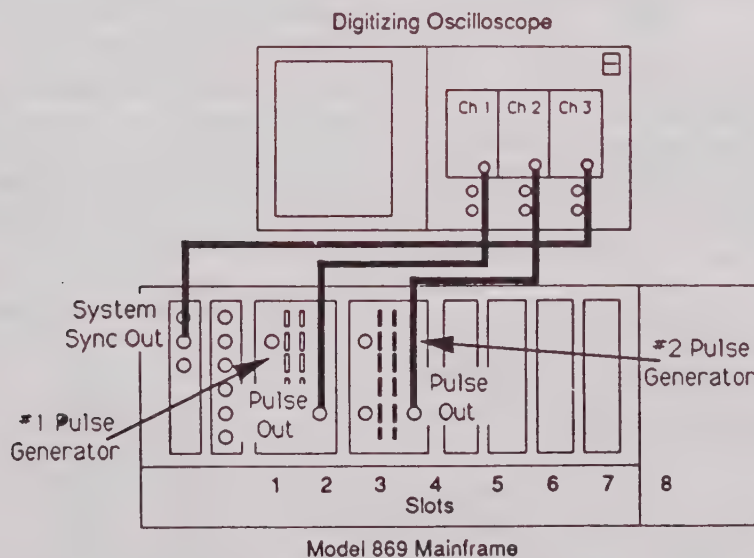


Figure 3-23. Master/Slave Example Hookup

NOTE

Set the oscilloscope to trigger on Ch.3, the System Sync Output.

- Using the Channel Select key and the numeric keypad, select #1 for channel 1, change the following parameters, and then press **Execute**:

Reset:	Reset (F1)
--------	------------

Performs a reset of the module parameters.

Output:	On
---------	----

Applies signal to the Output connector.

Frequency:	10 MHz
------------	--------

Changes frequency from the default to 10 MHz.

Sync Mode	Indep
-----------	-------

Set channel 1 to independent mode.

- Using the Channel Select key and the numeric keypad, select #2 for channel 2, change the following parameters, and then press **Execute**:

Reset:	Reset (F1)
--------	------------

Performs a reset of the module parameters.

Output:	On
---------	----

Applies signal to the Output connector.

Frequency:	5 MHz
------------	-------

Changes frequency from the default to 5 MHz.

Sync Mode	Indep
-----------	-------

Sets channel 2 to independent mode.

- Verify that the oscilloscope waveforms for all of the channels are operating independently of each other and are at their programmed frequency. To further verify their independence, change the channel two frequency to 4.9 MHz and observe that the waveform frequencies are not synchronized with each other.
- Set channel 1 pulse generator module to "Master".
- Set the channel 2 pulse generator module to "Slave".
- Verify that the frequency of channel 2 (Slave) is synchronized to channel 1 (Master).
- Temporarily remove the channel 2 output cable and connect the Mainframe "System Sync Output" to Ch.3 of the oscilloscope.
- Verify that the signal at the System Sync Output is a 10 MHz square wave. This signal is picked off of the internal SSync Bus. By connecting this signal to the System Sync Input of another mainframe chassis two or more mainframes can be synchronized together.

3.25 GPIB OPERATION

The IEEE-488 General Purpose Interface Bus for the Model 680 Mainframe uses a single connector and interface for all of the instrument modules in the chassis. A single primary address is used for the entire Mainframe System.

The chassis' primary address can be set by either the DIP switch on the rear panel or by programming the address on the Mainframe front panel. The DIP switch has eight switches, five of which are used for setting the GPIB primary address. The next one is for MATE enable and the last one is the front panel enable. The primary address can also be programmed from the front panel if this switch is enabled.

Secondary Addressing

The individual modules use a secondary address (as per IEEE-488.2 standard) for commands to each individual module. The addressing format is as follows:

0 = Mainframe, 1 thru 4 = Channel(s), 9 = Global

The available secondary addresses are 0 through 9. The Mainframe System commands are sent to address 0. The 680-03 plug-in modules (being double-wide modules) are addressed as 1 through 4, with modules being numbered by their physical order in the chassis. Module 1 being closest to the Ref/Cal board and module 8 being closest to the power supply. Module 9 is a virtual module containing the global commands that broadcast to all of the modules and to the mainframe.

3.25.1 GPIB Compliance Requirements

The Model 869 Pulse Generator Mainframe uses the IEEE-488.2 "Codes, Formats, Protocols and Common Commands" as a guide for the GPIB interface. The following interface functions are applicable to the Model 869 mainframe and modules:

Source Handshake: SH1
Acceptor Handshake: AH1
Talker: TE6
Listener: LE4
Service Request: SR1
Remote/Local: RL1
Parallel Poll: PPO
Device Clear: DC1*
Device Trigger: DT1
Electrical: E1

* DC1 also resets the instrument.

Talk messages are terminated with the LF EOI. Listen messages are terminated as delineated by the IEEE-488.2 standard. Carriage Returns are treated as white space.

The Model 869 Mainframe GPIB software interface uses a subset of the IEEE-488.2 Standard, "Codes, Formats, Protocols and Common Commands For Use With ANSI/IEEE Std 488.1 — 1987, IEEE Standard Digital Interface for Programmable Instrumentation."

Standard Model 869 Mainframe:

		Terminator
0	=	LF/EOI
1	=	CR/LF

Model 869MATE Mainframe:

		Mate	Terminator
0	=	Disabled,	LF/EOI
1	=	Enabled,	CR/LF

NOTE

The second switch from the top of the rear panel switch ADDRESS SELECTOR selects the line terminator for the standard Model 869. For the Model 869MATE, it enables/disables MATE. The terminator is different for enable and disable.

3.25.2 GPIB Command Definitions

The Model 869 uses three kinds of GPIB commands:

1. Mainframe chassis specific commands.
2. Common commands.
3. Module specific commands.

Table 3-21 lists all of the Model 869 channel specific commands and all of the common commands (marked with an *) and table 3-22 the mainframe commands.

Table 3-21. Pulse Generator GPIB Command Set

Command	Range / String	Function
<u>MODE</u>		
MOde	0 to 5 (default = 0)	Selects main operating mode
CoNtinuous	0	Continuous waveform mode
TRiggered	1	Triggered (one cycle) mode
Sync_Gate	2	Synchronous gating mode
Async_Gate	3	Asynchronous gating mode
BuRst	4	Burst mode
External_Width	5	External width mode
MOde?	MODE n	Returns main mode
Burst_Count	1 to 10E6 (default = 2)	Sets number of cycles in burst
Burst_Count?	BURSTCOUNT n	Returns number of cycles in burst
Gate_OFF	_____	Closes gate for A_GATE/s_gate modes
Gate_ON	_____	Opens gate for A_GATE/s_gate modes
<u>FUNCTION</u>		
FuNction	0 to 2 (default = 2)	Selects the module waveform output.
Single_Pulse	0	Selects single pulse output.
Double_Pulse	1	Selects double pulse output.
SQuare	2	Selects squarewave output.
FuNction?	FUNCTION n	Returns module output waveform
<u>LEVEL</u>		
LeVeL_Upper	-4 to +10 (default = 0.5)	Sets upper level voltage.
LeVeL_Upper?	LEVELUPPER f	Returns upper level voltage
LeVeL_Lower	-5 to +9 (default = 0.5)	Sets lower level voltage
LeVeL_Lower?	LEVELLOWER f	Returns lower level voltage.

ATTenuator ENable Disable ATTenuator?	0 to 1 (default = 0) 0 1 ATTENUATOR n	Selects Attenuator operation On or Off. Turns the Attenuator On. Turns the Attenuator Off. Returns status of the Attenuator.
<u>TIMING</u>		
FRequency FRequency?	10E-3 to 200E6 (default=1E3) FREQUENCY f	Sets generator output frequency Returns generator output frequency.
PeRiod PeRiod?	5E-9 to 1E2 (default=1E-3) PERIOD f	Sets period of main output. Returns period of main output.
Pulse_Delay Pulse_Delay?	0 to 2E3 (default=20E-9) PULSEDELAY f	Sets pulse delay of generator output. Returns pulse delay of generator output.
Pulse_Width Pulse_Width?	5E-9 to 2E3 (default=5E-9) PULSEWIDTH f	Sets pulse width of generator output. Returns pulse width of generator output.
LEading_edge LEading_edge?	1E-9 to 50E-6 (default=2E-9) LEADINGEDGE f	Sets leading edge transition time. Returns current leading edge transition time.
Trailing_Edge Trailing_Edge?	1E-9 to 50E-6 (default=2E-9) TRAILINGEDGE f	Sets trailing edge transition time. Returns current trailing edge transition time
<u>OUTPUT</u>		
OuTput OFF ON OuTput?	0 to 1 (default = 0) 0 1 OUTPUT n	Turns module outputs on/off. Opens output relays. Closes output relays. Returns output on/off mode.
POLaRity Normal Complement POLaRity?	0 to 1 (default = 0) 0 1 POLARITY n	Selects the output waveform polarity. Normal output waveform. Complements the output waveform. Returns the output waveform polarity.
<u>SYNC</u>		
Sync_Output OFF Gate Clock Sync_Output?	0 to 2 (default = 2) 0 1 2 SYNCOUTPUT n	Selects sync output source. Disables sync output. Selects the gating signal as the sync signal. Selects clock output as the sync signal. Returns sync output source.
<u>TRIGGER</u>		
TRIGger_Input OFF External_trigger System_trigger	0 to 2 (default = 0) 0 1 2	Selects trigger input source. Disables trigger input. Selects external BNC as trigger input source. Selects system trigger as trig input.

TRIGger_Input?	TRIGGERINPUT n	Returns trigger input source.
Trigger_LeVeL Trigger_LeVeL?	-10 to 10 (default = 1.6) TRIGGERLEVEL f	Sets response level to ext trigger. Returns trigger response level.
TRIGger_Output OFF External_trigger	0 to 4 (default = 0) 0 1 2 3 4	Selects trigger output source. Disables trigger output. Selects ext trig input as trig output. Selects delayed trigger output. Selects width trigger output. Selects sync as trigger output.
Width_one_shot Sync_output TRIGger_Output?	TRIGGEROUTPUT n	Returns trigger output source.
Trigger_SLoPe Positive Negative Trigger_SLoPe?	0 to 1 (default = 0) 0 1 TRIGGERSLOPE n	Selects response slope of ext trig. Respond to positive exttrig slope. Respond to negative exttrig slope. Returns selected trigger slope.
Manual_Trigger	_____	Triggers waveform.
<u>CONFIGURATION</u>		
CoNFiGuration INdependent MaSter SLave CoNFiGuration?	0 to 2 (default = 0) 0 1 2 CONFIGURATION n	Select single/multi module operation. Configure for single generator. Selects generator as master. Sets generator to slave mode. Returns configuration.
<u>AUTO CAL</u>		
*CAL?	n	Starts AutoCal & returns status.
@CAS?	n	Returns status of last AutoCal.
AutoCAL_Enable	_____	Enables module AutoCal corrections.
AutoCAL_Disable	_____	Disables module AutoCal corrections.
QuickKCAL	_____	Quickly calibrates current setups.
<u>STORED SETTING</u>		
*SAV	1 to 99	Stores module setup.
*SAV	-1 to -99	Deletes a stored module setup.
*RCL	1 to 99	Recalls specified module stored setting.
*RCL (...)	1 to 9, (-1 to -9)	Stores (...) global (module and System) settings.
<u>RESET</u>		
*RST	_____	Selects reset parameters for module or global reset for modules and system.

<u>SELFTEST</u>		
*TST?	n	Starts module Self-test and returns status. Returns status of last Self-test.
@STS?	n	
<u>MISC</u>		
EXECute	_____	Executes command string.
*IDN?	WAVETEK,680-03, or WAVETEK, 869,	Returns module identification 0,Vn.n.n and software version(Vn.n.n).
*OPC	_____	Will set operation complete bit of ESR.
*CLS	_____	Clears event status register.
*ESE	0 to 255 (default = 0)	Sets event status enable mask.
*ESE?	n	Returns event status enable mask.
*ESR?	n	Returns event status register value.
*SRE	0 to 255 (default = 0)	Sets service request enable mask.
*SRE?	n	Returns service request enable mask.
*STB?	n	Returns service request status byte.
*TRG	_____	Trigger command to module.
@CME?	<ASCII string>	Query for command error message.
@EXE?	<ASCII string>	Query for execute error message.
@QYE?	<ASCII string>	Query for query error message.
@DDE?	<ASCII string>	Query for device dependent error message.

Notes:

*Commands: Uppercase characters are mandatory,
 Lowercase characters are optional and
 Underscore is optional (for readability).*

For the value of a parameter, the string or numeric equivalent may be sent.

Numbers used in command strings and on queries are either floating point(f) or integer(n) as noted.

<ASCII string> means an ASCII string message will be returned in these cases.

*Ranges are for parameter, there may be times when these limits are not valid due to other parameter setups. For example:
FUNCTION SQUARE:FREQUENCY 100E6 is o.k. but in the case of FUNCTION DOUBLE_PULSE:FREQUENCY 100E6
would not be o.k. Max frequency of double pulse is 50E6. See specifications for possible conflicts.*

Table 3-22. Mainframe Specific GPIB Commands

Command	Range / String	Function
<u>SYSTEM</u>		
TRIGger_Input	0 to 4 (default = 4)	Selects system trigger mode/source.
Internal	0	Selects internal trigger generator.
Ext_Normal	1	Selects external trigger source.
Ext_Events	2	Selects divided external trigger.
Ext_Delayed	3	Selects delayed external trigger.
OFF	4	Disables system trigger source.
TRIGger_Input?	TRIGGERINPUT n	Returns selected trigger source.
Trig_Delay_Time	100E-9 to 100 (default=100E-9)	External system trigger delay time.
Trig_Delay_Time?	TRIGDELAYTIME f	Returns external trigger delay time.

Trigger_eVents Trigger_eVents?	2 to 1E7 (default = 2) TRIGGEREVENTS f	Event delayed ext trig number. Returns event delayed ext trig number.
Trigger_FReq Trigger_FReq?	1E-2 to 1E7 (default=10E3) TRIGGERFREQ f	Sets internal trigger frequency. Returns internal trigger frequency.
SsYNC Independent Slave SsYNC?	0 to 1 (default = 0) 0 1 SSYNC n	Selects system sync mode. Selects independent system sync. Selects Slave system sync mode. Returns system sync mode.
REFerence INTernal EXTernal REFerence?	0 to 1 (default = 0) 0 1 REFERENCE n	Selects 10 MHz reference source. Selects internal 10 MHz reference. Selects external 10 MHz reference. Returns 10 MHz reference source.
UTILITY		
BeeP OFF ON	0 to 1 (default = 1) 0 1	Sets beep on/off for front panel keys. Turns beep tone off. Turns beep tone on.
Viewing_Angle Viewing_Angle?	0 to 45 (default = 0) VIEWINGANGLE n	Sets viewing angle of display. Returns viewing angle of display.
BackLight OFF ON	0 to 1 (default = 1) 0 1	Controls display backlight. Turns display backlight off Turns display backlight on.
GPIB		
Front_Panel OFF ON	0 to 1 (default = 1) 0 1	Controls access to the front panel. Turns front panel off. Turns front panel on.

Table 3-23 describes those Model 869 common commands that do not conform to the IEEE-488.2 definition. All of these common commands are identified with the prefix in their command string.

Manufacturers of function modules other than Wavetek do not necessarily conform to the IEEE-488.2 protocols and may have command sets that are not compatible with the common commands described here. Check the manufacturers programming guide for further information.

Table 3-23. Nonstandard Commands

String	Command Name
@CME?	Command Error Query
@EXE?	Execution Error Query
@DDE?	Device Dependent Error Query
@QYE?	Query Error Query
@STS?	Report status of last Self-test, without invoking a new Self-test
@CAS?	Report status of last AutoCal, without invoking a new AutoCal

3.25.3 GPIB Error Handling and Status Reporting

Errors and status in the Model 869 System are handled as described for Device Status Reporting consistent with the IEEE-488.2 standard in Chapter 11. Errors and status may be monitored by reading the IEEE-488.1 Status Register, either by serial polling the Model 869 Mainframe or by sending a Status Byte read command (*STB?) to the Model 869. Each channel has its own Status Byte associated with its own secondary address. The serial poll or the *STB? query has to be sent to the channel's primary and secondary address.

Three bits in the Status Byte are defined as follows:

- Bit 6 (DI07): RQS/MSS
RQS/MSS acts as a summary bit for the rest of the Status Byte bits. If any of the other Status Byte bits are asserted along with their corresponding mask bits in the Service Request Enable Register, then the RQS/MSS bit will be asserted. This allows the controller to test the RQS/MSS bit for selected information (selected by the mask bits in the Service Request Enable Register) automatically without having to mask and test the Status Byte manually.

RQS is in response to a serial poll and is partially defined in the IEEE-488.1 standard and further defined in the IEEE-488.2 standard. RQS will be true during a serial poll if the Model 869 has an SRQ true condition pending.

MSS is in response to a *STB? query and is defined in the IEEE-488.2 standard. MSS will be true if the logical AND of the Status Byte bits and a mask byte, the Service Request Enable Register yields a true result in any bit location (except bit 6 of course). The only bits used in the Model 869 are bit 4 (DI05) and bit 5 (DI06) mentioned below.

- Bit 5 (DI06): ESB
Standard Event Status Bit Summary Message. This is a summary message bit for the Standard Event Status Register.
- Bit 4 (DI05): MAV
Message Available Queue Summary Bit. This bit is always true if another byte is available to be output to the controller. When the queue is empty, the MAV bit is cleared.

The remaining bits in the Status Byte have no effect.

The ESB bit is a summary bit for another status register, called the Standard Event Status register, which is used

to extend the types of status information available to the controller from the instrument's status functions. The IEEE-488.2 document defines all eight bits for particular functions. The Model 869 only uses a subset of these.

They are as follows:

- Bit 7: Not Used (Power On)
- Bit 6: Not Used (User Request)
- Bit 5: Command Error
Set to true whenever a syntax error is encountered in the command string to the Model 869.
- Bit 4: Execution Error
Set whenever a parameter exceeds the range available for that parameter, except for inter-parameter conflict errors which are handled by bit 3.
- Bit 3: Device Dependent Error
Set whenever the instrument module encounters an error specifically associated with the operation of that type of module. This includes inter-parameter conflict errors.
- Bit 2: Query Error
Set whenever a query is made to the Model 869 for which no response is available.
- Bit 1: Not Used (Request Control)
- Bit 0: Operation Complete (see *OPC)
Set whenever the last command has finished execution and the Model 869 is ready to accept another command or results from the last query are available.

This register, along with a mask enable register called the Standard Event Status Enable Register, is used to set the ESB bit in the Status Byte of the Model 869 GPIB interface. The Standard Event Status Register (ESR) is bit-wise logically ANDed with the Standard Event Status Enable Register (ESE) to generate the ESB bit. If any of the bits in the ESR are true along with the corresponding bits in the mask ESE, then the Event Status Summary Bit (ESB, bit 6) in the GPIB Status Byte will be asserted. This way the Status Byte can be serial polled to see if any one of the conditions in the ESR has occurred.

3.25.4 GPIB Example Program

This Pulse Generator GPIB programming example utilizes an IBM or compatible computer operating with a National GPIB card installed.

If the desired set-up parameters for the Pulse Generator are:

Output	on
Function	single pulse
Upper level	4
Lower level	0
Period	1E-6
Width	100E-9
Transition time	
Delay	300E-9
Mode	burst
Trigger input	external
Trigger level	0.75

The command string for these parameters will look like:

```
"OUTPUT ON; FUNCTION SINGLE_PULSE;
LEVEL_UPPER 4; LEVEL_LOWER 0; PERIOD 1E-6;
PULSE_WIDTH 100E-9; PULSE_DELAY 300E-9;
MODE BURST; BURST_COUNT 25;
TRIGGER_INPUT EXTERNAL; TRIGGER_LEVEL
0.75; EXECUTE"
```

The same string using minimum uniqueness:

```
"OT ON;FNC SP;LVLU 4;LVLL 0;PR 1E-6; PW 100E-
9;PD 300E-9;MODE BR; BC 25; TRIGI E;TLVL
0.75;EXEC"
```

The following commands are machine specific.

To do an AutoCal and read status:

```
Write @UUT:"*CAL?"
```

Delay for 2.5 minutes or set controller timeout for same.

```
Read @UUT:A$
```

```
Status of cal = val(A$)
```

The same process may be used for Self-test by changing CAL to TST and set delay/timeout to 45 seconds.

Program Example 1:

```
10 !The following lines set up the pulse generator
20 !for single pulse with a width of 25E-6 and
30 !delay of 40E-6. The levels are set to +4
40 !and -2v with output turned on.
50 LET X=2 !the secondary address of pulse genera-
tor
60 WRITE @70900+X:"OUTPUT ON; LEVELUPPER4;
LEVELLOWER -2;EXEC"
70 WRITE @70900+X:"FUNCTION SINGLEPULSE;
PULSEWIDTH 25E-6; PULSEDELAY 40E-6; EXEC"
250 END
```

3.26 ERROR CODES AND MESSAGES

The error detection software algorithms built into the instrument will detect the majority of all error conditions (programmed or failures) that may occur within this instrument. It is impossible to predict every possible error or failure because of the numerous possible combinations of parameters and conditions that could cause improper operation.

3.26.1 Error Types

This section classifies errors and events and describes how the Model 869 responds to them.

Limit Errors

A limit error when a parameter is programmed beyond its allowable limits. For example, if an attempt is made to set an output amplitude to 1000V when the maximum allowable amplitude is 32V, line two of the display will show an out of limit message.

Executable Conflict Errors

A conflict error occurs when two or more parameters are within their respective allowable limits but are invalid when programmed simultaneously. Setting an output amplitude and offset in such a way as to cause waveform distortion will cause a conflict error message to appear on line 2 of the display.

Data Errors

Data errors relate to loss of internal memory. An example would be an error detected when an attempt is made to recall a stored setting.

Hardware Error

Hardware errors occur when a hardware failure condition either occurs spontaneously (like output protection) or is detected as a result of programming (like quick cal failure). As these errors occur, the appropriate message occurs on the display.

Non-executable Conflict Errors

These errors are similar to the executable conflict errors but involve parameter settings which make no sense or which may cause unpredictable results on the output which could damage a test device connected to the output of the instrument. Errors of this type do not execute the command.

3.26.2 Normal Operation Error Codes

The following is a list of the possible error messages that might occur during operation. Each is listed with an explanation of what the error means.

- amplitude out of range
An Upper and Lower Level combination has been programmed that is not within the allowable limits. Reprogram the amplitude after referring to figure 1-6, "Upper Level/Amplitude Specifications, Attenuator Enabled", and figure 1-5, "Upper Level/Amplitude Specifications, Attenuator Disabled."
- amplitude vs frequency error
An amplitude and frequency combination has been programmed that is not within the allowable limits. Reprogram with either a lower frequency or a lower amplitude.
- <parameter>: limit error
The <parameter> is used here to indicate a programmable parameter that has been programmed to value larger (or smaller) than the maximum (or minimum) allowed for that parameter. Reprogram using a value equal or less than the maximum (or greater than the minimum) allowable value. See specifications in paragraphs 1.5 and 1.6.
- delay > period
The pulse delay has been programmed greater than the period and the mode of operation is not triggered. In triggered mode delay has a maximum value of 2000 seconds.
- delay + lead + width + trail > period
The delay, leading transition time, trailing transition time, and pulse width combination is greater than the "period minus ramp slide" value for the double pulse function, when the mode is not triggered. Reprogram using a smaller delay value, smaller width value, or smaller transition times.
- freq > 100 MHz for square wave only
A frequency greater than 100 MHz has been programmed for a function other than squarewave. Frequencies greater than 100 MHz can be programmed only for the squarewave function in the Continuous mode. Select a frequency lower than 100 MHz or change the function to squarewave.
- freq > 100 MHz for cont mode only
Frequencies greater than 100 MHz (up to 200 MHz) can be programmed only in Continuous mode. Select a frequency lower than 100 MHz or change the mode to Continuous.
- lead + width + trail > period
The leading transition time, trailing transition time, and pulse width combination is greater than the "period minus ramp slide" value while not in Triggered mode. Reprogram using a smaller width value or smaller transition times.
- lead + width + trail > dbl pulse delay
The leading transition time, trailing transition time, and pulse width combination is greater than the "delay minus rampslide" value for the double pulse function. Reprogram using a smaller width value or smaller transition times or increase the delay time.
- lead + trail > width error
The combination of the leading and trailing transition times is too large for the requested width time. You must either reduce the lead or trail times, or increase the width time.
- lead > maximum for squarewave
The leading edge transition time has been programmed which is too large for the selected square-wave frequency. Use a smaller transition time or decrease the frequency.
- memory allocation error
Indicates a problem with System Configuration or System software. Call the factory. Module is still functional but AutoCal cannot be performed.
- trail > maximum for squarewave
A trailing edge transition time has been programmed which is too large for the selected squarewave frequency. Use a smaller transition time or decrease the frequency.
- transition time vs ampl range error
A transition time and amplitude combination has been programmed that is not within the allowable limits. Reprogram either transition time or amplitude or both after referring to figure 1-7 "Allowable Transition Time Ranges and Specifications."
- transition ranges not alike error
A leading and trailing transition time combination has been programmed that is not within the allowable limits. Both transitions must be within the same range as shown in figure 1-7 "Allowable Transition Time Ranges and Specifications."
- trig not allowed in square wave
Square waves are produced in the Continuous mode and therefore cannot be triggered.
- upper < lower level error
The Upper level has been programmed to be less positive than the Lower level. Upper level must always be more positive than the Lower level.

3.26.3 Module Self-test Error Codes

Self-test allows the Model 869 Pulse Generator to perform various tests utilizing the built-in DVM and frequency counter. The objective of Self-test is to provide a quick go/no-go functional test and to help a technician isolate a problem to a specific circuit or subassembly.

Error Codes

The Self-test status is displayed on the front panel in hexadecimal notation at the conclusion of the Self-test operation. Over the GPIB, the status returned will be in decimal notation. Each bit in the binary equivalent of the hexadecimal number represents a failure depending on whether the bit is set (failed) or cleared (passed). For example, a Self-test status of 12 (0002 0010) would indicate two failures; a delay osc. circuit error and an amplitude circuit error. The Status error codes, error messages, and problem areas are given in the following list.

0	No error	80	Width DAC circuit errors • Width DAC min • Width DAC max
1	Upper level circuit errors • Upper level min • Upper level max	100	Transition Time DAC circuit errors • Pos Trans DAC min • Pos Trans DAC max • Neg Trans DAC min • Neg Trans DAC max
2	Amplitude circuit errors • Amplitude min • Amplitude max	200	Set Point Amplifier errors • v10pct min • v10pct max • v90pct min • v90pct max
4	Attenuator circuit errors • Attenuator x2 • Attenuator x4 • Attenuator x8	400	Pulse Pos Trans time errors • Pos Trans, Cap 0, min • Pos Trans, Cap 0, max • Pos Trans, Cap 1, min • Pos Trans, Cap 1, max • Pos Trans, Cap 2, min • Pos Trans, Cap 2, max • Pos Trans, Cap 3, min • Pos Trans, Cap 3, max
8	Frequency/Sync Output errors • VCO min in, 3v • VCO max in, 21v	800	Pulse Neg Trans time errors • Neg Trans, Cap 0, min • Neg Trans, Cap 0, max • Neg Trans, Cap 1, min • Neg Trans, Cap 1, max • Neg Trans, Cap 2, min • Neg Trans, Cap 2, max • Neg Trans, Cap 3, min • Neg Trans, Cap 3, max
10	Delay Osc circuit errors • Delay triggerable osc >115 MHz • Delay triggerable osc <90 MHz	1000	AutoCal circuit errors • v10pct DVM error=xx • Detection pulse limit error • Counter reset error • Counter init error • AutoCal burst timeout errors • Total count read error
20	Delay DAC circuit errors • Delay DAC min • Delay DAC max	2000	External trigger level errors • Trigger DAC min • Trigger DAC max
40	Width Osc circuit errors • Width triggerable osc >115 MHz • Width triggerable osc <90 MHz	4000	Memory allocation error

3.26.4 System Selftest (sec address 0)

Once started, the system self test takes about 20 to 30 seconds to complete. Most of this time is spent waiting for the internal trigger frequency to settle before measuring it with the counter on the ref/cal board.

The error code returned from the system self test is the sum of the individual error codes for each signal tested, and will either be zero if all tests have passed or a decimal number representing the failed test(s).

Error Code	Test1	Test2	Test3	Test4	Test5
Pass	0	0	0	0	0
Fail	1	2	4	8	16

For example, an error code of "3" would indicate that tests 1 and 2 had failed.

The Model 869 system self test is composed of five sub-tests. Four of these tests check signal paths and components using an onboard counter. One test uses the onboard DVM.

Test 1

Signal tested	Tol	Error	Description
10 MHz clock	0.005%	1	System reference clock

This test measures the frequency of the 10 MHz system reference clock (U14). It tests the external reference signal only if the external reference is selected. Since this same signal is used as the frequency reference for the counter being used to test it, we do this test only to verify the signal path and operation of the counter circuitry.

Test 2

Signal tested	Tol	Error	Description
10 MHz oscillator	7%	2	Synchronous oscillator, gateable

This test measures the frequency of the 10 MHz synchronous gateable oscillator circuit using the onboard counter to a tolerance of 7%.

Test 3

Signal tested	Tol	Error	Description
175 kHz oscillator	5%	4	DVM intergration oscillator

This test measures the frequency of the 175 kHz DVM oscillator circuit using the onboard counter to a tolerance of 5%.

Test 4

Signal tested	Tol	Error	Description
Internal trigger	0.1%	8	System trigger reference

This test measures several frequencies derived from the 10 MHz clock by the internal trigger circuitry using the onboard counter to a tolerance of 0.1%. The frequencies 5, 10, 50, 100, 500 Hz and 1 kHz are measured by the onboard counter using period average mode. The frequencies 5, 10, 50, 100, 500 kHz, 1 and 10 MHz are measured by the onboard counter using gated mode with a gate time of 100 ms.

Test 5

Signal tested	Tol	Error	Description
Temp	15-35°C	16	System Temperature reference

The DVM is set up to monitor the temperature near the rear of the Reference/Calibration Board by measuring the voltage from an LM35DZ temperature sensor. A measurement in the range of 15 to 35 degrees Celsius gives a rough indication that the DVM chip is working.

3.26.5 Module AutoCal Error Codes

AutoCal allows the Pulse Generator to calibrate its functional circuits utilizing built-in software and stored data values. AutoCal provides the customer the highest level of long term accuracy possible, and may help a technician isolate a malfunction to a specific circuit or subassembly if the AutoCal fails.

Error Codes

The AutoCal status is displayed on the front panel in hexadecimal notation at the conclusion of the Self-test operation. Over the GPIB, the status returned will be in decimal notation. Each bit in the binary equivalent of the hexadecimal number represents a failure depending on whether the bit is set (failed) or cleared (passed). For example, an AutoCal status of 12 (0002 0010) would indicate two failures; a delay error and an amplitude error. The Status error codes, error messages, and problem areas are given in the following list.

0	No error	4000	Memory allocation error Not enough memory available for performing the AutoCal operation, call the factory.
1	Upper level DAC/Amp circuit errors (Output Bd) • Upper level:dvm error, hicnt • Upper level:dvm error, locnt	8000	AutoCal Enable/Disable This is not an error. If this bit is set then AutoCal corrections are disabled. AutoCal corrections can be re-enabled via the AutoCal menu.
2	Amplitude DAC/Amplifier circuit errors (Output Bd) • Amplitude:dvm error, upper_hicnt • Amplitude:dvm error, lower_hicnt • Amplitude:dvm error, upper_locnt • Amplitude:dvm error, lower_locnt • Min ampli error x.xx, xxxx • Max ampli error x.xx, xxxx		
4	Attenuator circuit errors (Output Bd/Hybrid Bd) • Attenuation:dvm error • Atten x2 out of tol: x.xx • Atten x4 out of tol: x.xx • Atten x8 out of tol: x.xx		
10	Delay circuit errors (Timing Bd) • Delay:counter error • Delay:osc range error=xxx.x		
40	Width circuit errors (Timing Bd) • Width:counter error • Width:osc range error=xxx.x		
200	AutoCal circuit errors (Output Bd) or DAC errors (Ref/Cal card) • Setpoint cal:dvm error=xx • v10pct cal, vlo error xxx.x • v10pct cal, vhi error xxx.x • v90pct cal, vhi error xxx.x • v90pct cal, vlo error xxx.x		
400	Hybrid or current source errors (Output Bd) • Pos, v:x.x, c:x,d:xxxx, r:x.xx • Neg, v:x.x, c:x,d:xxxx, r:x.xx		
800	Hybrid clamp voltage errors (Output Bd) • Vhyb low < min error: x.x • Vhyb low > max error: x.x • Vhyb up < min error: x.x • Vhyb up > max error: x.x		
1000	AutoCal circuit (Output board) or counter/DVM error (Cal/Ref card) • Detection pulse limit error • Counter reset error • Counter init error • AutoCal burst timeout error • Total count read error		

3.26.6 Quick Cal Error Messages

Quick Cal allows the user to calibrate the instrument at a user defined set of parameters. Quick Cal provides the customer the highest level of short term accuracy possible and can help a technician in isolating the cause of an error message to a specific circuit or subassembly.

Error Messages

The on-screen messages produced by Quick Cal errors are given in the following list. The error messages have been grouped under headings that indicate the most likely circuit to troubleshoot.

AutoCal circuit (Output board) or counter/DVM error (Cal/Ref card)

- Detection pulse limit error
- Counter reset error
- Counter init error
- AutoCal burst timeout error
- Total count read error

Width circuit error (Timing Bd)

- Width:counter error
- Width:osc range error=xxx.x

Delay circuit error (Timing Bd)

- Delay:counter error
- Delay:osc range error=xxx.x

3.26.7 Global AutoCal Codes

Three hexadecimal digits are used to represent which module or channel number had a failure when a global selftest or autocal is carried out. This is illustrated in figure 3-24.

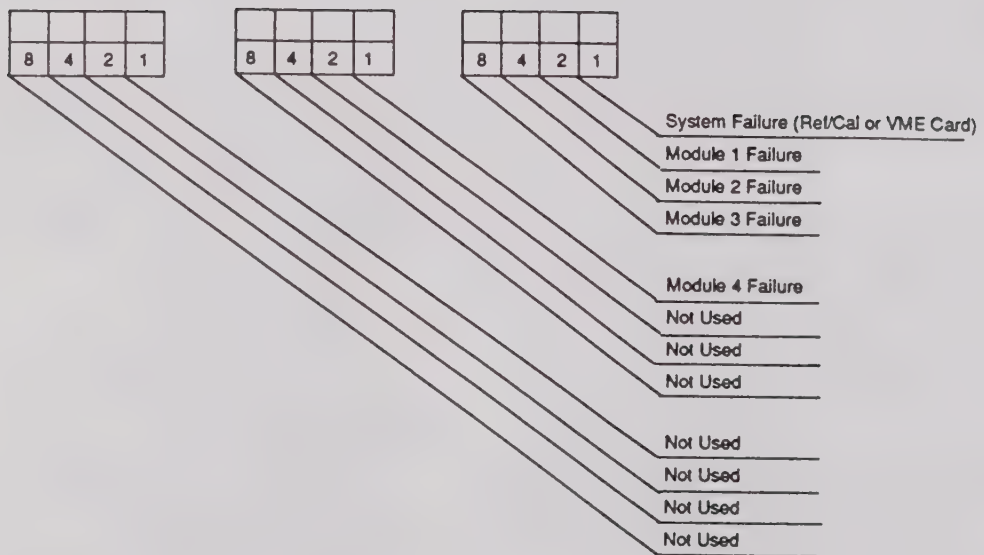


Figure 3-24. Global AutoCal Error Codes

Wavetek Model 680-03 Pulse Generator Information about Automatic Calibration

General

Most of the pulse generator circuits, except the Analog Delay and Width circuits, are calibrated automatically. The accuracy of the automatic calibration is dependent on two key components located on the Ref/Cal Board of the Mainframe. They are the +10V voltage reference for the DVM and the TCXO 10 MHz Reference for the Frequency Counter.

Voltage Reference and DVM

An LT1021 from Linear Technology is used for the 10V reference. The stability of this voltage reference is better than 5 ppm/°C. The voltage is reduced down to 2.049 V and used as the voltage reference of the internal DVM. During calibration of the Mainframe, an external 4.000V $\pm$ 200 μ Vdc voltage standard, traceable to NIST, is used to calibrate the DVM reference voltage to the specified limit.

A 12-bit A/D converter is used as the DVM which can measure dc voltage with 0.025% accuracy. Voltages from the generator modules can be switched by multiplexers to the input of the DVM for measurement during the auto-calibration process. The peak voltage of an AC signal is measured by holding the signal at its peak level and taking a dc voltage measurement using the DVM. Peak-to-peak voltage is then calculated from the positive and negative peak voltage measurements.

Counter

The 10 MHz precision frequency from the TCXO is used as the time base for the counter for all timing measurements. The accuracy and stability of the TCXO is better than 1 ppm and requires no calibration. However, to ensure the precision of the time base and traceability to NIST, it is recommended that the frequency of the 10 MHz Reference out be evaluated periodically with an external frequency counter, traceable to NIST (National Institute of Standard and Technology).

Limited by the 10 MHz reference, the time resolution of the 24-bit counter is limited to 100 nsec.

Additional Calibration Circuit

Each pulse generator module also includes a timing measurement circuit which is used to calibrate the pulse transition times, pulse delay and width parameters.

Parameters Require Auto-Calibration

Upper Level is calibrated by setting the generator to trigger mode, inverted waveform. The voltage level is then measured with the internal DVM.

Pulse Amplitude is calibrated by setting the generator to trigger mode, normal waveform. The voltage level is then measured with the internal DVM. Lower level voltage is calculated by subtracting the amplitude from the upper level voltage.

Digital Pulse Delay is generated by counting the clock period of a delay line oscillator, running at approximately 100 MHz. The frequency of the delay line oscillator is precisely measured during auto-cal and the result stored in memory.

Transition time affects the accuracy of the delay due to the ramp slide effect, so that additional calibration data must be taken to compensation for the variations.

Analog Pulse Delay circuit generates an additional delay to the digital delay of up to 10 nsec with 100 psec resolution. This circuit requires two manual calibrations.

Digital Pulse Width is generated by counting the clock period of another delay line oscillator, also running at approximately 100 MHz. The frequency of the second delay line oscillator is precisely measured during auto-cal and the result stored in memory.

Transition time affects the accuracy of the width due to the ramp slide effect, so that additional calibration data must be taken to compensation for the variations.

Analog Pulse Width circuit generates an additional width to the digital width of up to 10 nsec with 100 psec resolution. This circuit requires two manual calibrations.

Transition Time is calibrated by using a special circuit within the pulse generator module. In this circuit, two level detectors can be programmed to 10% and 90% of the pulse amplitude. A pulse of which the duration (width) is the same as the 10% to 90% transition time is generated. The time duration is measured by the counter circuit in the Mainframe. Because the resolution of the counter is limited to 100 nsec, for fast pulses, a

special circuit is used to stretch the pulse by 200 times allowing their actual width to be measured. A detail description of this circuit can be found in the Theory of Operation Section.

Pulse Frequency requires no calibration. A 4-digit phase lock loop circuit is used to generate the precision frequency. Its accuracy is the same as the 10 MHz frequency reference in the Mainframe.

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